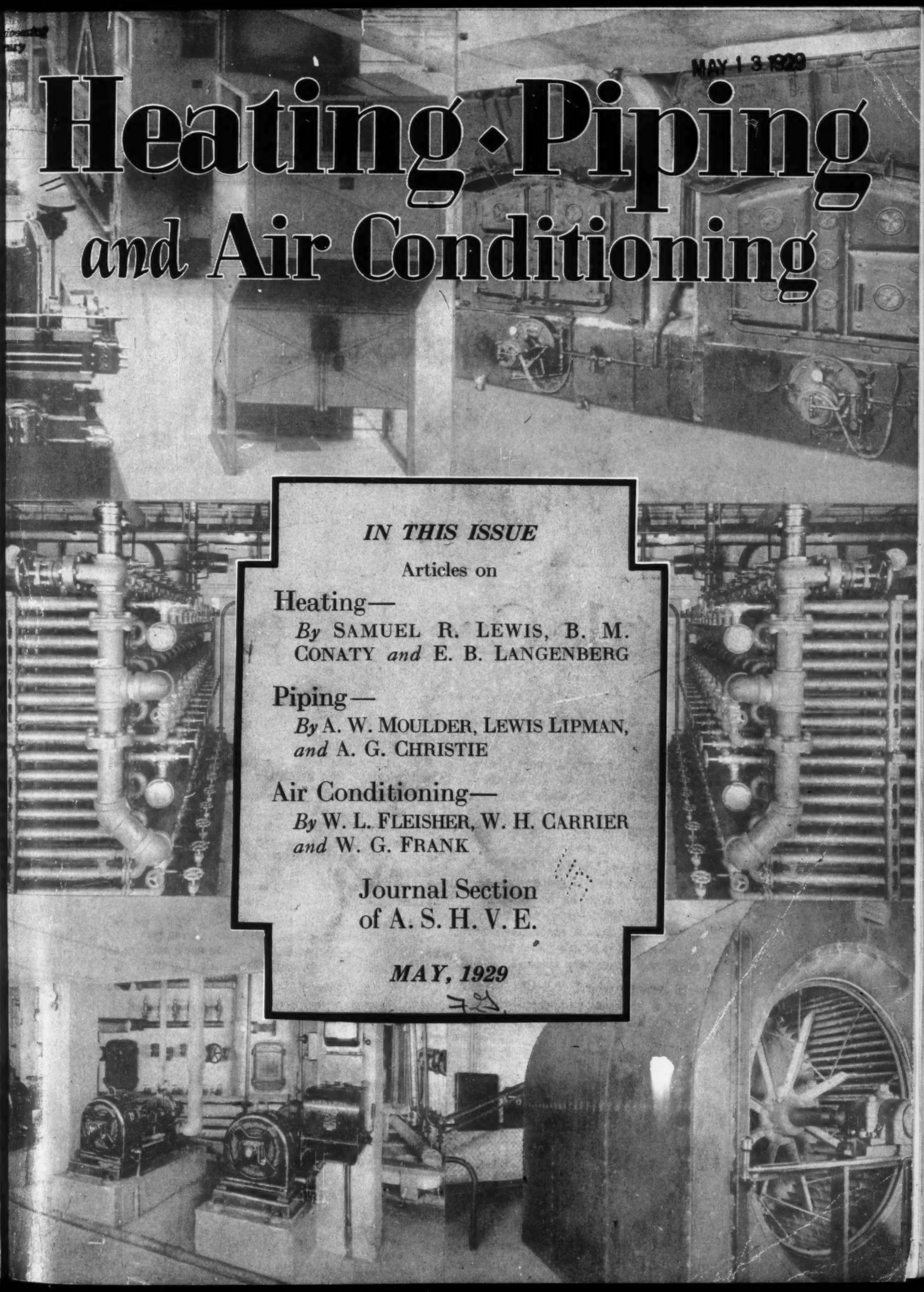
MAY 1 3 1929

# Heating · Piping and Air Conditioning



*IN THIS ISSUE*

Articles on

Heating—
*By* SAMUEL R. LEWIS, B. M. CONATY *and* E. B. LANGENBERG

Piping—
*By* A. W. MOULDER, LEWIS LIPMAN, *and* A. G. CHRISTIE

Air Conditioning—
*By* W. L. FLEISHER, W. H. CARRIER *and* W. G. FRANK

Journal Section
of A. S. H. V. E.

*MAY, 1929*

**Heating·Piping**
and Air Conditioning

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*View of Main Lobby in New Addition*

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*The* EDITOR'S PAGE

# Heating · Piping and Air Conditioning

**THE consulting and contributing editors, whose articles will be found in this and future issues, are the reader's assurance of worth while engineering information. They have been selected for their ability—as engineers and as writers.**

## *AN ARTICLE THAT IS "TYPICALLY LEWIS"*

Samuel R. Lewis carries on a consulting engineering practice in Chicago, which has brought him in touch with some of the country's largest heating projects. He is a past president of the A. S. H. V. E. and one of the leading forces in that society's research activities. Those who know him will appreciate our description of his article in this issue as "typically Lewis." Those who are to come to know him through these pages will eventually recognize that description as referring to an original style of expressing sound engineering data and practice.

## *THIS FIRST ISSUE REPRESENTS MONTHS OF PLANNING*

It has been interesting work for our editorial organization to prepare this first issue and arrange for future issues which will serve this field as we have promised to serve it.

First, of course, we have had to establish an editorial policy. We have had to define exactly the divisions of the field with which we are to concern ourselves—as, for instance, in heating we are to concentrate on the larger types of construction. Then, we have had to weigh the importance of all the subjects coming under our editorial jurisdiction and work out the proper proportions of each that will satisfactorily cover the interests and needs of our readers. We have had to appreciate that one issue, no matter how large, can not cover the whole range of heating, piping and air conditioning trends, developments and problems and have, therefore, had to work out a program far in advance that, as a whole, embraces the type of service we are pledged to render.

All of this planning has been done. It has enabled us to present a first issue aimed to touch upon most of the leading factors which will later come in for detailed attention and to line up the proper material for the future.

The indispensable part of the whole program has been the co-operation of leading engineers in the field who have taken the subjects our schedule calls for and prepared articles on them. Contributors to this first issue are typical of the engineering talent which may be expected in each issue. We want to take this opportunity of telling our readers about each of these writers.

## *ENGINEERS DISCUSS INDUSTRIAL PIPING REFRIGERATION*

Lewis Lipman has been closely associated with the refrigeration field since 1912 in a designing and research capacity. His experience has brought him in touch with all the applications to which refrigeration has been adapted and his present work is contributing to the further development of this science.

A. W. Moulder has a background of long experience in the contracting, engineering and manufacturing divisions of the heating, power, and industrial piping field. His counsel and contributions will be most effective in providing suitable material for the reader concerned with any phase of piping—a statement supported by his article, "Industrial Piping," in this issue.

A. G. Christie is professor of mechanical engineering at Johns Hopkins University, Baltimore. We went to Professor Christie for an article on what the trend toward higher pressures and temperatures meant to the design, installation and maintenance of piping, and he responded with a presentation of data and experience which will be found in this issue under the title of "Piping for Higher Pressures and Temperatures."

W. H. Wilson is foreman of steam fitters in one of the world's largest industrial plants.

B. M. Conaty is a district heating engineer with a large company in this field, with an experience which has brought him in touch with every phase of district heating in its design, installation and operation.

## *THEY ARE MAKING HISTORY IN THE FIELD OF AIR CONDITIONING*

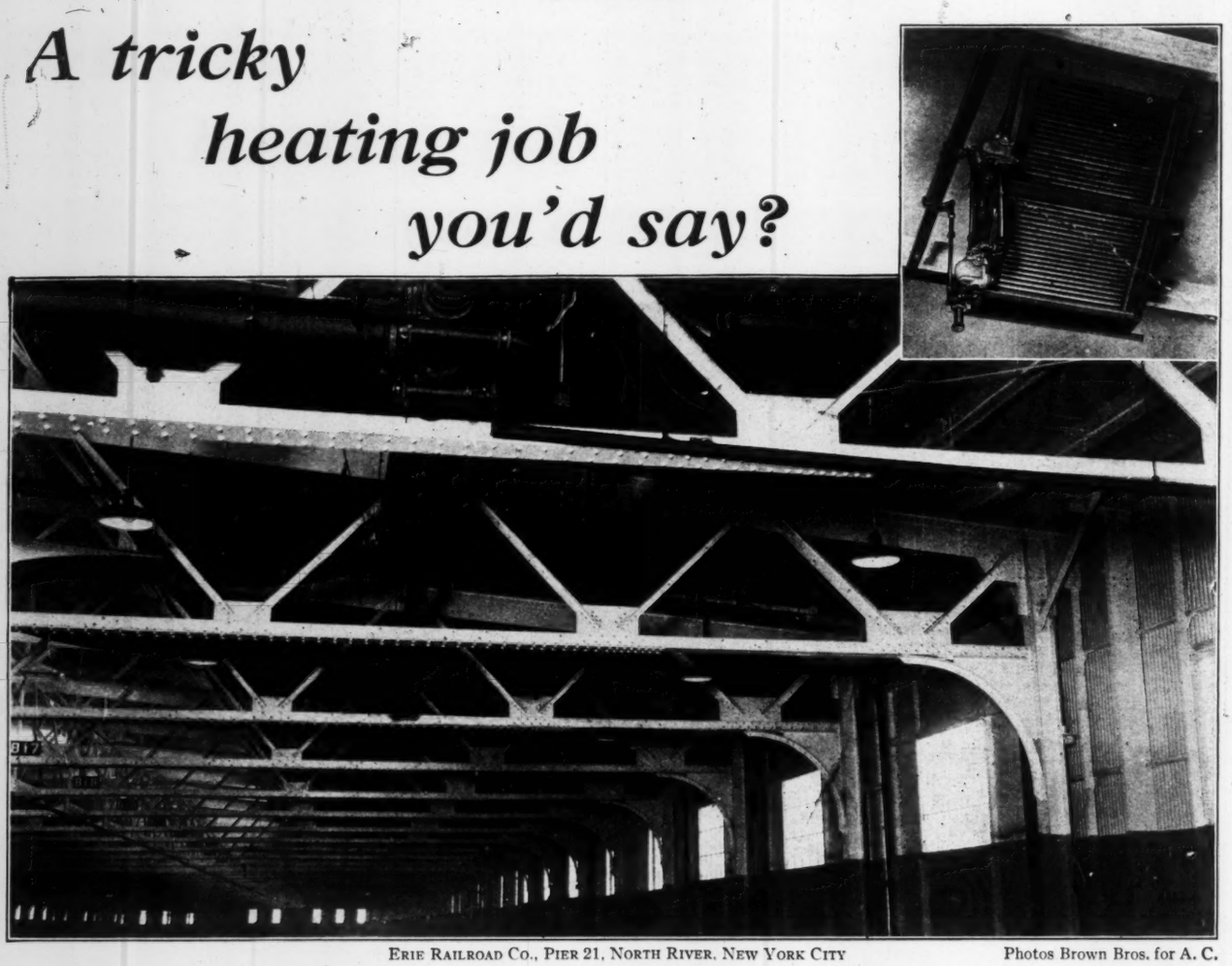
Walter L. Fleisher, whose article, "Air Conditioning—Its Record in Industry," gives us a fine background for future editorial development of the application of air conditioning to the manufacturing processes, is well known in this field. A member of the A. S. M. E., the A. S. H. V. E. and the Heating and Piping Contractors National Association, Mr. Fleisher is at the present time devoting all of his attention to the development of air conditioning.

Willis H. Carrier is known to everyone who has heard the term "air conditioning." He can truly be called a pioneer in this science and for that reason his ideas of its future possibilities can be accepted as an accurate picture of coming air conditioning accomplishments.

W. G. Frank's experience in air filtration dates from work on the development of this science as a young man in Germany. He is now chief designing engineer for a consolidation of air filter manufacturers.

E. B. Langenberg has contributed an article on warm air heating, particularly as applied to churches. Mr. Langenberg has had a long experience in designing, contracting and manufacturing in the warm air heating field and is one of the leading forces in the warm air division of the A. S. H. V. E.

# *A tricky heating job you'd say?*



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## OUR NEXT ISSUE

*Some of the articles to look for next month are:*

**THE MOTIVE POWER DEPARTMENT ON A BUDGET**
*By George B. Mulloy*

**AIR CONDITIONING—IN THE FIELD OF HUMAN COMFORT**
*By Dwight D. Kimball*

**DUST EXPLOSIONS IN A GRAIN ELEVATOR**
*By Prof. Albert E. Macdonald*

**HOSPITAL HEATING AND VENTILATION**
*By Alfred J. Offner*

**NATIONAL STANDARDIZATION OF PIPING**
*By Sabin Crocker*

**HEAT—WITH OR WITHOUT POWER**
*By Prof. E. O. Eastwood*


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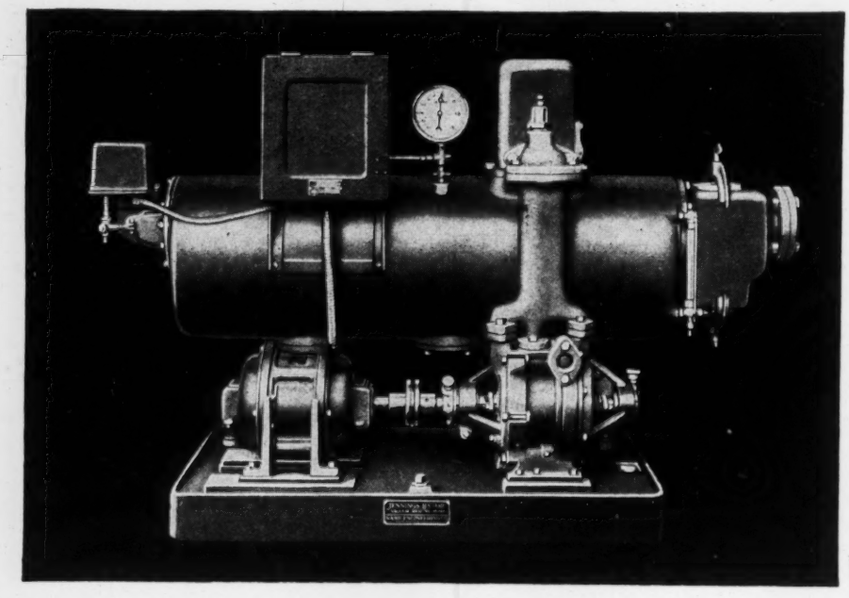
# Before this pump is installed—



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# Heating · Piping and Air Conditioning

Vol. I | May, 1929 | No. 1

## In the Interests of the Engineer and Contractor

In appearing with this first issue before seven thousand engineers and contractors in the field of heating, piping and air conditioning, the publishers of this new journal have somewhat the same feelings as those experienced by a man newly elected to office and about to make his speech of acceptance and promise. On such an occasion there is a feeling of gratitude for the confidence expressed in him by his constituents. There is a feeling of responsibility—that confidence must be justified. And there is a feeling of determination to serve and to work to the best of his ability, for there is a big job expected of him.

We have that feeling of gratitude. It is an unusual expression of confidence to have seven thousand men—consulting engineers, contractors and supervising and operating engineers in industrial plants, public utilities, institutions, schools, office buildings and such structures—place their vote for this new journal on what might be called a campaign promise. That feeling is merged with one of responsibility—a responsibility to fulfill that promise. And the two combine into a feeling of obligation, and a pledge, to render a service as a publication that the developments and possibilities of this large field have made a necessity, and that our readers expect of us.

The design, installation and operation of heating, piping and air conditioning systems and equipment afford an opportunity for an engineering editorial service which is limited only by the possibilities for improving human comfort and health and increasing production efficiency.

This issue is the first step in a carefully reasoned program of operation aimed to supply the technical and practical information and data needed in this work. It makes a promise an actuality. It looks ahead to an every month enlargement of the opportunity to serve better.

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The above consulting and contributing editors represent a fund of engineering knowledge and experience that seldom appears in such quantity as a united force. Their combined biographies would leave little, if anything, uncovered in the field of heating, piping and air conditioning.

These men have interested themselves in the plans of HEATING, PIPING and AIR CONDITIONING to render a unique editorial service to those engineers and contractors concerned with the design, installation and operation of heating, piping and air conditioning systems and equipment. They have been prompted to do so by a sincere desire to contribute to the progress of the industry of which they are a part. In their willingness to provide articles and advice on problems that confront this field, they afford the reader a rare opportunity to secure engineering counsel and guidance.

We take this occasion to introduce them as a group to our readers. All of them are known to some of our readers already—many of them, perhaps, to all of our readers, for their reputations are national and international. They shall, of course, become better known through contact with them in the pages of this new engineering journal.

R. V. SAWHILL, *Editorial Director*
L. B. SPAFFORD, *Engineering Editor*
CHAS. E. PRICE, *Research Editor*

# AIR Conditioning
## Its Development in Industry

*By* Walter L. Fleisher

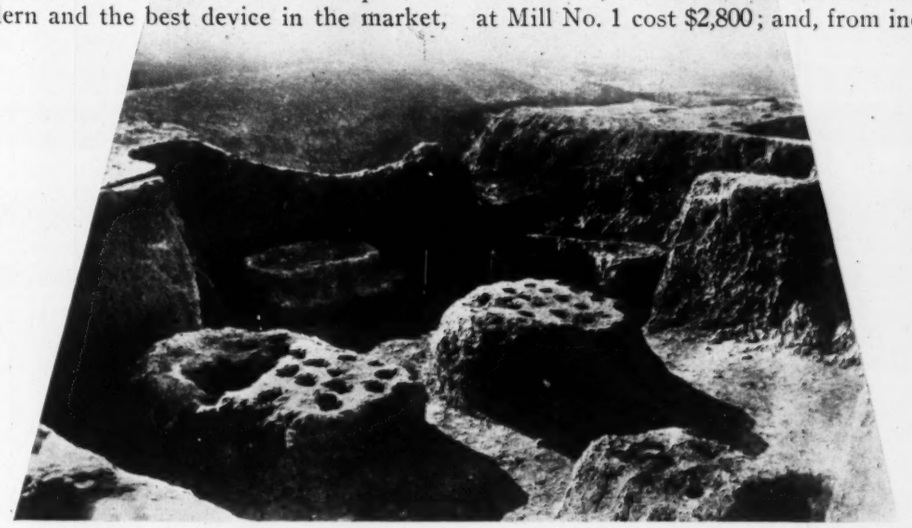
> *"Manufacturers noted in the early stages of industry that there were certain days when their goods seemed to work better than at other times. Those days were measured for atmospheric conditions and then duplicated mechanically. It was from these duplications that modern air conditioning has progressed."*

NOTHING can possibly give a better idea of the advancement and development of air conditioning in industry than a comparison of the comments of Eugene N. Foss before the New England Cotton Manufacturers' Association in 1889, on the cost of installation and operation of air conditioning in an industrial plant, and the elaborate and expensive installations which are regularly being installed today. A brief quotation from this address, is as follows:

### *Cost and Operation Then and Now*

"In reference to regulating the humidity of the air, we have stated that it was not in the range of this paper to discuss the advantages of moistening the air in cotton mills. We take it as an accepted fact that a high and constant humidity in the spinning of yarns and in weaving is necessary. All are undoubtedly more or less familiar with the Garland apparatus, and have read the admirable treatise of Mr. Garland upon the subject. We suppose that the Garland apparatus had heretofore been accepted as the most modern and the best device in the market, and we know that it has been largely adopted. This apparatus utilizes the principle of an atomizer, and calls for an extended circulation of water and air pipes through the mill, together with a water tank and filtering device. This complication of parts and elaborate arrangement offers all the disadvantages of overhead steam pipes, in being the receptacle of dust and lint, of danger from damage by leakage, annoyance from leaky valves, and the breaking of glass air tips, with the care of the water tank and filtering devices, to say nothing of the cost of running the air pump. The first cost is necessarily great, and the results are by no means satisfactory, since some of the same objections that are offered to steam pots and other devices are applicable here, in that the moisture is not uniformly distributed, and the relative humidity will vary with the location of the atomizer. . . .

"The cost of installation of any one of the modern and approved moistening systems calls for a large outlay for the plant itself. Mr. Sanford of the Globe Yarn Mills, states that the Garland moistening plant at Mill No. 1 cost $2,800; and, from inquiries that we



THE APPROACH TO MODERN AIR CONDITIONING IS FIRST EXEMPLIFIED IN THE BAKERY WHERE PANS OF WATER WERE PUT IN ROOMS OR OVENS AND HOT COALS INTRODUCED INTO THE PANS TO GIVE OFF MOISTURE ESSENTIAL TO THE UNIFORM FERMENTATION OF THE LOAVES. THE ABOVE IS A PICTURE OF WHAT IS BELIEVED TO BE THE WORLD'S OLDEST BAKERY. IT LIES UNCOVERED ON THE SITE OF THE ANCIENT CITY OF JEMDET NASR. THE CLAY OVENS ARE BELIEVED TO DATE FROM ABOUT 4000 B. C.

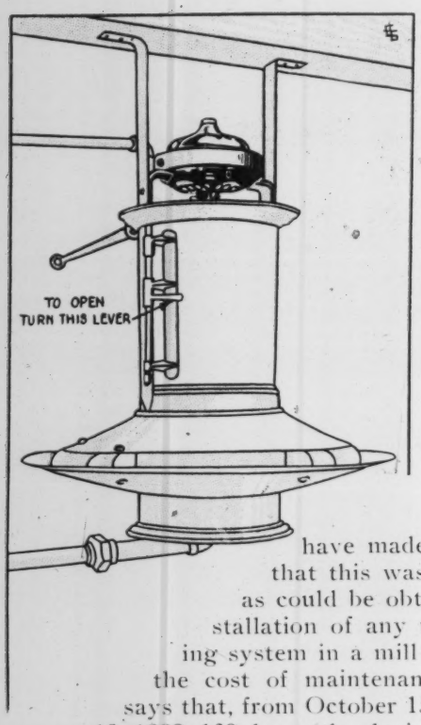



FIG. 1.—A MODERN MOISTENING HEAD, THE GENERAL TYPE OF WHICH HAS NOT CHANGED THROUGH MANY YEARS. THE EFFICIENCY AND METHOD OF ATOMIZATION HAS CHANGED BUT THE GENERAL PRINCIPLES ARE THE SAME

have made, we should say that this was as low a figure as could be obtained for the installation of any modern moistening system in a mill of this size. Of the cost of maintenance, Mr. Sanford says that, from October 15, 1888, to March 15, 1889, 130 days (the device not being used on Sundays and very moist days), it required 58,500 pounds of coal to actuate the pump, to say nothing of repairs. At $5 a ton (2,240 pounds), this means an expense of $130.58 for six months, for coal. In addition to this, the system requires pure water, which had to be taken from the city main at a cost of $1 per month, which makes a total of $136.58 as the cost of maintenance for six months. . . ."

Undoubtedly, the Garland apparatus referred to in this address is what is known as a direct moistening head, but the type of apparatus employed is not the amusing part of the excerpts which we have quoted from this early article. Mr. Foss's main objection at that time, to the introduction of air conditioning, was the excessive cost of $2,800 and the excessive operating cost amounting for six months to $130 for coal and $6 for water. Compare this expense with the following.

Within the last several years there have been installed equipments in rayon plants, for air conditioning alone, costing more than $250,000 and requiring for their proper operation as much as 50,000 pounds of steam an hour. Not only that, but without this air conditioning, these plants could not operate nor produce the goods which they have to sell.

For purposes of depicting the advances that have been made in air conditioning and the need which the owner feels for such results as can be obtained from modern air conditioning, a comparison between the statements made by Mr. Foss in 1889 and actual installations made in 1928, a period of thirty-nine years, would indicate the progress of air conditioning in industry better than any theoretical discussion which we might present to the readers of this article.

## What Is Air Conditioning?

In an article attempting to define and then to show the development of a science such as air conditioning, one must be careful of one's definition and then, having defined the subject, one must be careful to limit the history and development well within the confines of the definition.

Air conditioning is a broad term referring generally to both the temperature and the moisture content of the air maintained within an enclosure and, in its use in industry, the relationship of both temperature and moisture content at a definite temperature must be considered together. Neither temperature or moisture content considered alone has any particular application in the science of air conditioning. For every temperature there is a definite moisture-holding capacity and for the amount of moisture in a definite quantity of air there is a definite saturation point. For example, at 50 degrees F., the moisture-holding capacity of one cubic foot of air when saturated is 4.08 grains, while at 60 degrees F. it is 5.75 grains; at 70 degrees F., 7.98 grains and at 80 degrees F., 10.93 grains. Now raise the sensible temperature 10 degrees F. at each of these conditions and what happens. The 50-degree air is raised to 60 degrees F.; the relative humidity which was 100 per cent drops to 70 per cent; the wet bulb which was 50 degrees, the same as the dry bulb, changes to 54½ degrees, but the dew point remains at 50 degrees, no moisture having been added. The 60-degree air is raised to 70 degrees; then the relative-humidity which was 100 per cent drops to 71 per cent and the wet bulb which was 60 degrees rises to 63¾ degrees, but the dew point remains at 60 degrees, no moisture having been added. Similarly, at 70 degrees, the changes are 71 per cent, wet bulb 73½ degrees, and dew point 70 degrees. At 80 degrees the changes are 72 per cent, wet bulb 82½ degrees and dew point 80 degrees.

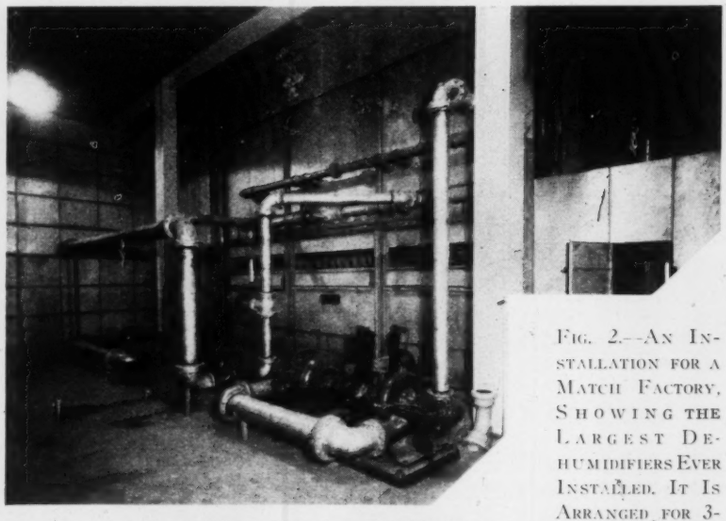


FIG. 2.—AN INSTALLATION FOR A MATCH FACTORY, SHOWING THE LARGEST DEHUMIDIFIERS EVER INSTALLED. IT IS ARRANGED FOR 3-STAGE HUMIDIFICATION AND IS EQUIPPED WITH 3 PUMPS

The interesting thing to note is that within the rather narrow range of working temperatures, for the same rise in sensible temperature, the relative humidity remains about the same and the wet bulb follows approximately a straight line, but the dew

point remains constant so long as no moisture is added. The wet bulb is the important measurement as it measures the total heat of the air and the vapor. The relationship between the two and the control of this relationship are the two elements entering into modern air conditioning.

Until we were able, by a knowledge of the properties of the air and its capacity to hold moisture as a vapor, and by the development of apparatus and instruments to control and record its psychrometric condition, so that both temperature and moisture content could be regulated together and in unison, air conditioning was a crude art and very little of a science.

### Instruments and Apparatus for Controlling Temperature and Humidity

A wide variety of instruments and apparatus is in use today for automatically controlling the temperature and humidity conditions of the air and for indicating and recording those conditions.

In the majority of installations, the valves controlling steam for humidifying and heating, cold water or brine for dehumidifying and cooling, and the dampers controlling the relative volumes of fresh, recirculated and bypassed air, are operated by compressed air, the supply of which is regulated by thermostats actuated by dew point, wet bulb or dry bulb temperatures or hygrostats actuated by the temperature and vapor pressure of the air under control.

More rarely the valves and dampers are controlled electrically through the make and break of circuits in mercury contact thermostats.

In many small installations, self-contained thermostatic valves are used. In this class of apparatus, the thermostatic element is filled with a volatile liquid, the vapor pressure of which varies with the temperature and is exerted in a diaphragm attached to the valve stem so that the position of the valve varies with the temperature.

The indicating instrument most commonly used for determining the condition of the air is the sling psychrometer which, when properly used under normal air conditions, gives the dry bulb and wet bulb temperatures with a high degree of accuracy.

There are several types of recording instruments. Some employ mercury or a volatile liquid as the expansion element while others use the thermocouple. In air conditioning work, the instrument most commonly used is that which records the dry bulb and wet bulb temperatures. Recorders which give dry bulb temperature and relative humidity are also available.

One type of wet bulb and dry bulb recorder employs a small fan to create the proper velocity of air over the wet bulb. The wet bulb is usually provided with a wick or porous sleeve to which water is supplied. Recently there has been developed a method of exposing the wet bulb element, whether of the indicating or recording thermometer or of the thermostat, to the wet bulb temperature of the air. In this apparatus (see Fig. 6), the element is immersed in water which is made to take on the wet bulb temperature of the air by spraying it into a current of the air under control or under test; this new instrument does not use wicks and sleeves and does not depend upon saturating the air.

Instruments are also made which combine recording and controlling of the dry bulb and wet bulb temperatures, the same expansion elements being used for both purposes.

*"The engineers engaged in the development of air conditioning have been few and of pioneering tendencies. Humanity at large owes them a great debt, for the future of industry and the comfort of the individual to a large extent are*

*dependent upon the work they did."*

*So says W. L. Fleisher in this article, a man himself who has devoted years to the development of air conditioning systems and equipment.*

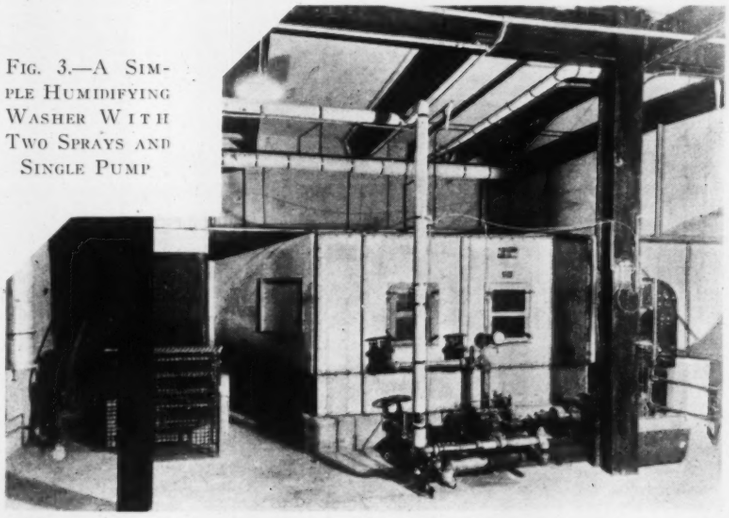


FIG. 3.—A SIMPLE HUMIDIFYING WASHER WITH TWO SPRAYS AND SINGLE PUMP

### Some Basic Principles of Thermodynamics

For those desirous of understanding air conditioning and following it as a profession, nothing is as important as a thorough knowledge of the basic principles of engineering thermodynamics, involving specifically an understanding of and an ability to use intelligently a great mass of data pertaining to machinery and apparatus for heating and cooling, evaporating and condensing, melting and freezing, moistening and drying, and pertaining to the properties of water vapor, the properties of air, the properties of mixtures of air and water vapor and the thermal and physical relationships of one to the other.

The names of Boyle, Charles, Gray, Dalton, Regnault and a host of others, dating back to the late eighteenth and the very early nineteenth century are inextricably connected with this vast subject. Their

philosophical discussions and experimental work were applied principally to chemistry but the application to steam and then to air and vapor followed as practical use demanded. Just as the formula $V^2=2gh$ is the fundamental formula for motion, so $PV=RT$ is the fundamental formula for gases, where P=absolute pressure in pounds per square foot; V=the volume of one pound in cubic foot; R=a gas constant; and T=absolute temperature. The V in the first formula refers to velocity and the V in the second formula to volume of one pound of air in cubic foot. From this formula most of the problems of thermodynamics can be solved.

To illustrate in its simplest form, the truth of these statements as applied to air conditioning, let us take a cubic foot of air at 70 degrees dry bulb and 50 per cent relative humidity. There is a total heat value of this cubic foot of air 1.9 B.t.u. which is not changed up to the point of saturation at the wet bulb temperature of 57½ degrees. In other words, at 68½ degrees dry bulb and 55 per cent relative humidity, the total heat value is the same because the wet bulb is still 57½ degrees. When the characteristics of air are thoroughly understood, then one is prepared to embark on the design of set problems in air conditioning.

*To understand the science of air conditioning nothing is as important as a thorough knowledge of the basic principles of engineering thermodynamics.*

### The Dominating Factor in Air Conditioning

It is not too much to say that the wet bulb is the dominating factor in air conditioning. It is the difficulty of understanding the function of the wet bulb that has restricted the engineering of air conditioning to a selected few and that is likely to keep the engineering of air conditioning problems to that selected circle for some years yet.

In my thirty years experience in the heating and ventilating industry, I happened to be for ten years chairman of a committee on standardization, one of the principal duties of which committee was to work out a method of figuring radiation for household and industrial heating. When the work of determining a scientific method of figuring heat losses had been satisfactorily settled, it devolved on me to explain the method and reason for the determination. Our findings dealt only with sensible heat—latent heat and humidity were not a part of the problem—but it was difficult to make this simple determination clear to every one. It seems still more difficult to create a general understanding of the basic changes taking place in air partially saturated with moisture.

Air conditioning developed slowly from steam evaporation to water atomization and then to the saturation of air before its introduction into an enclosure. When the changes in the dry and wet bulb temperatures with relation to each other were thoroughly understood, the modern apparatus now used in air conditioning was developed.

After it was determined that there was a definite temperature of saturation for every "air state" (practical application of which understanding was carried so far forward by Willis Carrier), the advancement of air conditioning from its early crude state to its present development was rapid. Though the engineers engaged in this development have been few and of pioneering tendencies, humanity at large owes them a great debt; for the future of industry and the comfort of the individual to a large extent, is dependent upon the work they did and the risks they willingly encountered.

### The Reason for Air Conditioning in Industry

Practically all materials are hygroscopic; cotton, silk, wool, rayon, wood, leather, tobacco, each has a definite moisture content under which it reacts best to its surroundings. Warping, uniformity, texture and breakage are all more or less a function of this normal moisture content. It was this fact and the elimination of static electricity by high relative humidity that led to the introduction of air conditioning into industry.

Many substances have a definite hygroscopic content—by this we mean the ability normally to hold moisture in proportion to their dry weight. This is called "regain" and it varies greatly with the substance. This regain or moisture content varies with

FIG. 4.—AIR CONDITIONING IN A PRINTING ROOM

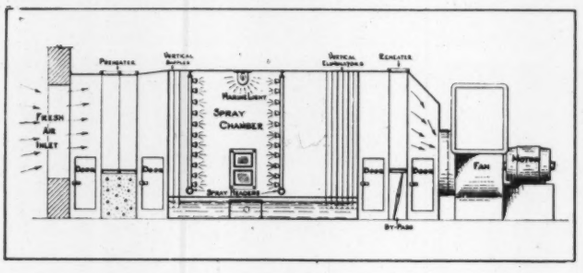



FIG. 5.—A CROSS SECTION THROUGH A TYPICAL CONDITIONING APPARATUS, IN WHICH TWO BANKS OF SPRAYS, SPRAYING IN OPPOSITE DIRECTIONS, ARE UTILIZED FOR HUMIDIFYING OR WHEN FURNISHED WITH COLD WATER FOR DEHUMIDIFYING

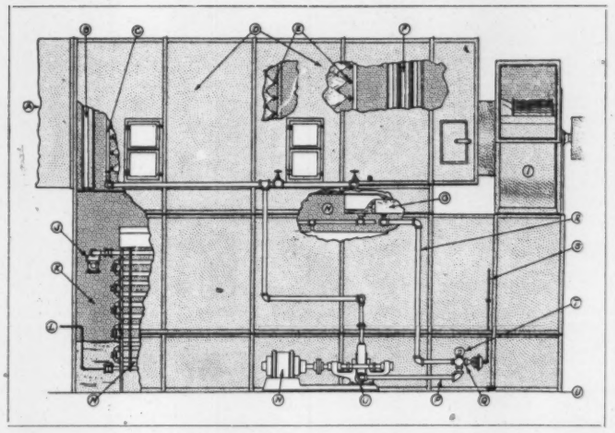


FIG. 6.—A TYPICAL DEHUMIDIFYING APPARATUS WITH THE COOLING COIL IN A BAUDELOT CHAMBER UNDERNEATH THE DEHUMIDIFIER. THIS APPARATUS IS FURNISHED WITH THREE BANKS OF SPRAYS, TWO SPRAYING AGAINST THE AIR AND ONE WITH THE AIR, FOR COMPLETE SATURATION

FIG. 7.— HUMIDIFYING A SLIVER DEPARTMENT OF A COTTON MILL

the relative humidity and sometimes with the absolute humidity. A material may absorb or give up moisture depending upon whether the surrounding atmosphere contains a greater or less percentage of moisture than the normal condition of the material. As most hygroscopic material is sold with a definite moisture content as a basis of value, it can readily be seen that deviation from this condition may entail great loss.

For instance, silk has a moisture content or normal regain of 11 per cent, cotton 8 per cent, wool 18 per cent, paper 5 to 6 per cent, flour 13 to 15 per cent and rayon 10 to 11 per cent. This normal condition is maintained when the material is subjected to a surrounding atmosphere of from 55 per cent to 75 per cent relative humidity. It readily can be seen that deviation from these conditions means loss to the seller and that consequently it is economic to maintain the conditions that will result in constant and normal regain.

It also happens that most materials react better to handling and reuse when the normal regain is continuously maintained. With modern high speed machinery, the heat given off by the machines raises the temperature of the surrounding air sufficiently to lower the relative humidity to such a point that without the addition of moisture artificially added, serious handicaps would be encountered; the material often becoming brittle or warped or highly charged electrically when the moisture contained is taken up by the surrounding air. To overcome these obstacles, the air conditioning pioneer has had to invent controls, dampers, mixers, differential thermostats and methods of distribution that are as involved in their basic ideas and as simple in their daily operation as any other scientific development in radio, aeroplaning or sound pictures.

The history of air conditioning dates back to almost pre-historic time. The moistening of fermenting doughs for uniform leavening, a true air conditioning problem, is authentically preserved in some of the prehistoric tablets; and as bread-making, and by bread we mean leavened bread, antedates any other recognized industry, air conditioning, though not recognized as such, has persisted for untold centuries.

### Industries Sought Suitable Climatic Conditions

The approach to modern air conditioning is first exemplified in the bakery where pans of water were put in rooms or ovens and hot coals introduced into the pans to give off moisture essential to the uniform fermentation of the loaves.

What the philosophical conceptions of the effects of moisture on materials may have been is not disclosed in the early literature on this subject. That the effect of evaporation was early recognized is demonstrated in the use of evaporating pans for the making of ice in the Egyptian deserts and the Arabian mountains and the drying of salt in China and around the Mediterranean. That anything so common as atmospheric moisture and its effects should not have been noted and commented upon is hardly possible, but the necessity to duplicate nature's phenomena was of little consequence until the machine age when quantity production required constant and uniform output.

The textile mill followed the bakery in the use of temperature and moisture as a necessary adjunct to the proper manufacture of cellulose base substances. When the manufacture of textiles was taken out of the home, where the individual could wait for the proper conditions in order to make the crude articles essential to comfort, small manufacturing plants were established at nearby places. Transportation being so crude, everything essential to the life of the community had to be made near its point of consumption. However, it did not take long to learn the points from which the best articles came, and factories were set up at those points because of the quality of the goods they produced. It developed that the points from which the best goods came were the points where the atmospheric conditions were most nearly correct for the manufacture of the goods in question. These facts became more and

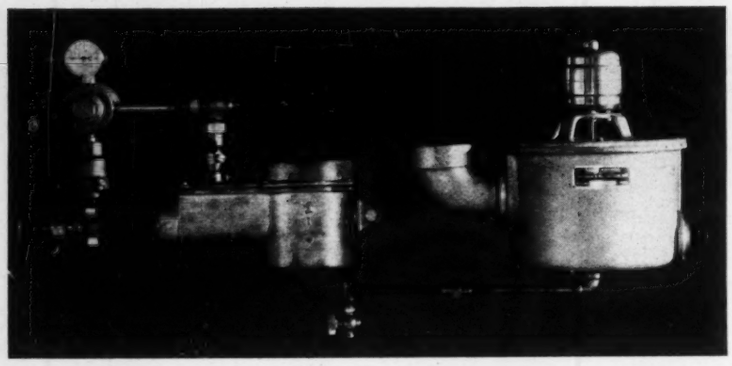


Fig. 8.—A Device for Controlling or Indicating From the Wet Bulb

more apparent with the advent of machinery and the industrial districts of the various manufacturing countries were located where the atmosphere was most suitable.

Not only were special sections of the country better adapted for the manufacture of different materials but different days were better than others. The addition of artificial heat complicated still more the difficulties of manufacture. Somehow or other, dry cold days in winter brought broken threads or warping woodwork or crusted doughs. Steam in pits around the edges of work rooms, wet cloths over dough troughs, steam in perforated pipes, all regulated by hand, helped out the conditions. Lancastershire in England, Lyons and Marseilles in France, Brussels in Belgium, selected because of their cool moist climates, all eventually resorted to artificial conditioning, and when emigration of these manufacturers to America took place, these people selected those places where the climatic conditions corresponded to those from which the emigrants had come. They selected New England, parts of New Jersey, and the Niagara Valley,—not where the raw material came from, but where the climate was most conducive to manufacturing. Climate and weather have had more influence upon the location of manufacturing plants than any other factor in our whole industrial life, not excepting water power and an adequate supply of cool soft water. If one recognizes that modern air conditioning has changed all this, one can readily see what an influence it has had, not only on manufacture but on our whole social and economic structure.

### Early Methods of Humidification

Going back through the early journals of the textile and paper industry, one finds that steam was the first method of humidification. Steam was utilized because the evaporation had already taken place before its introduction into the air and the latent heat essential to its change of state had been added in the boiler itself. Therefore, it could more readily be absorbed, but its effect upon the air was more difficult to control so far as sensible heat was concerned. In our evaporation today, the sensible heat taken out of the air to effect evaporation, has the effect of cooling the air by lowering the dry bulb.

The development of modern apparatus progressed about as follows: first, direct blowing of steam into the air, still largely practiced in bakeries, hat factories, glove and hosiery finishing, sizing and like industries; second, finely atomizing water directly into the air through so called "heads" of which an endless variety were and still are on the market; then the blowing of air over wetted surfaces, such as baffles, screens, cloths, etc.; then a combination of atomizers and baffles through which a current of air was forced; then the modern two- and three-spray washers and the two- and three-stage washers of an endless variety designed for complete saturation at a definite temperature.

### Involved Problems in Air Conditioning

As stated earlier in this article, manufacturers noted in the early stages of industry that there were certain days in the year when their goods seemed to work better than at other times. When air conditioning became an art, those days were definitely measured for atmospheric conditions and then were duplicated mechanically each day in order to accomplish the results obtained when such conditions occurred normally. It was from these duplications that modern air conditioning has progressed to its present state.

A great many problems in air conditioning are humidifying problems, that is, they involve the addition of moisture to the air delivered in order to maintain a condition of relative humidity that was destroyed by the heat given off by machinery, lights and the sensible heat of the workers. This is the simplest problem that the air conditioning engineer has to solve. When the problem involves keeping the temperature down to or near a desirable point, as well as maintaining a definite relative humidity, then the problem becomes intricate.

When it is realized that in systems using considerable outdoor air, the wet bulb and moisture content of the new air varies continually and that varying quantities must be used as well as varying amounts of steam and refrigeration, the problem becomes one of calculation commensurate with the most involved problem in physics. In many of these problems, the heat of combination must also be considered in order to arrive at a proper solution. Now, when it is considered that guarantees are made to maintain conditions within as close as ½ degree F. dry bulb at all times of the year, the accuracy of calculation required can be easily visualized. If cost of installation and operation were not a factor, a system could be made so large that errors could be covered by excess capacity—but today the expert figures very closely, and excess figuring would throw a bid out

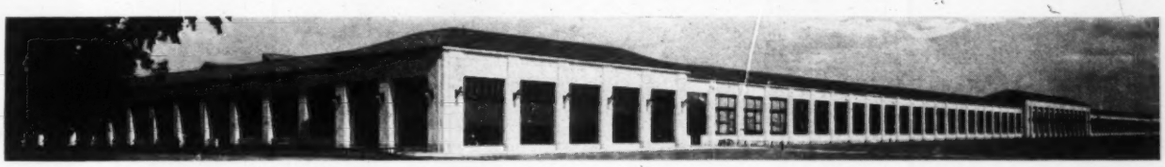
of the picture, either on first costs or operating costs.

A complete knowledge of refrigeration must be a part of the air conditioning engineer's equipment because in industry, as well as in the comfort field, refrigeration is often necessary to obtain the results required. For instance, in the bakery, the dough room, the cooling of the mixer air and loaf cooling, all being air conditioning problems, require refrigeration as an adjunct to the systems. In candy manufacturing, the packing, storage, machinery rooms and cooling tables require refrigeration. In rayon, the reeling and inspection departments require accurate results, and refrigeration must be used. In match factories, in rotogravure plants, in the making of chewing gum, gelatine and celluloid products, and in butterine plants, refrigeration is also necessary to the manufacturing process.

In the conditioning of mushrooms, the drying of photographic films, the cutting and perforating rooms of film laboratories, refrigeration is an essential part of the conditioning system.

This refrigeration effect is usually applied in the washer and dehumidifier and the amount of water circulated and atomized is dependent upon the heat transfer desired.

I do not feel that I can end this article without reference to Prof. A. S. Eddington's new book on "The Nature of the Physical Universe." In this book he says, "There is only one law of nature,—the second law of thermodynamics" which law says that the efficiency of a reversible engine depends only upon the temperatures between which it works. I leave this relationship to the deductions of the reader, but it is interesting to learn that one of the fundamental laws of air conditioning is used as the basis of reasoning for the new conception of the universe.



# A Letter to the Editor

## from John H. Zink, chairman

**Welding Committee, Heating and Piping Contractors National Association**

To the Editor:

Your active entry into the heating field through the medium of this publication presents to you many opportunities, and not the least of these is intelligent and continued publicity on the entire question of welding as applied to our industry.

The welding committee of the Heating and Piping Contractors National Association expresses to you its sincere hope for your continued success, and a friendly challenge that you accept your responsibility for full co-operation with those of us who are interested in having welding accepted and delivered by our members to the owner in a manner that will promote its general use.

The purpose of our committee will be to abolish, so far as we are able, the use of unsatisfactory standards, and to eliminate any idea of "shift for yourself" that may be in evidence among our members.

The scope of this work for the benefit of our contractors will include the design of new materials as well as a limit control on materials already in use. In addition, it will include the preparation of a welding manual that will enable our contractors to test the welding operator in their own shops in an inexpensive and satisfactory manner, and make available to such contractors the fundamentals necessary to supervise properly the design and installation work. This knowledge will enable him to determine accurately the various welding costs as well as permit him to sell welding in an intelligent and convincing manner.

We will also prepare and make available to the trade a detailed specification that will enable the owner and his consulting engineer to include welding as a principal part of their specifications. This will give them the assurance that the welding installation will be made under approved engineering standards and will dispel from their minds any doubts they may have as to the real economic value of welding. This specification will make mandatory the use of our new flanged welding neck as approved by our standardization committee, as well as the adoption of the "V" type weld as standard. It will present intelligent welding rod specification and such other control as will be deemed necessary to insure an installation which is in accordance with accepted standards.

We recognize that there has been a hesitancy to accept welding in some instances. This may be attributed to several causes. The principal one is its improper application. These objections will be overcome by the control we propose to make effective through the co-operation of our Heating and Piping Contractors National Association and other interested agencies who are co-operating with us.

Welding in our industry ceases to be a novelty and an experiment, and must be appreciated as a necessity. We are undergoing the same economic changes in our industry as those generally true in all others, and, in our opinion, welding best offers the opportunity to meet these changes.

We cannot hope to accomplish the educational work necessary to bring about these results without the fullest co-operation of our trade publications. They will

be the means by which we will release the findings of our committee, as well as the instrument through which there shall be a free exchange of ideas pertaining to this subject matter.

The fact that you are entering our field with a new publication is sufficient proof that you are alive to the possibilities and advantages both to yourself and our members. Our interests are the same, our field is large and important, and I feel sure that your enthusiastic reception is assured, and will be met by you with a welding program mutually satisfactory.

John H. Zink, Chairman,
Welding Committee, Heating and Piping Contractors National Association.

# Factory Uses Filtered Air for Unit Heaters

WITHIN the last five years or so, a remarkable increase has been witnessed in the use of unit heaters for heating and ventilating workrooms and factories. Their ability to heat large spaces quickly and evenly, flexibility of operation and the ease with which they control air circulation and distribution make them especially valuable for this service.

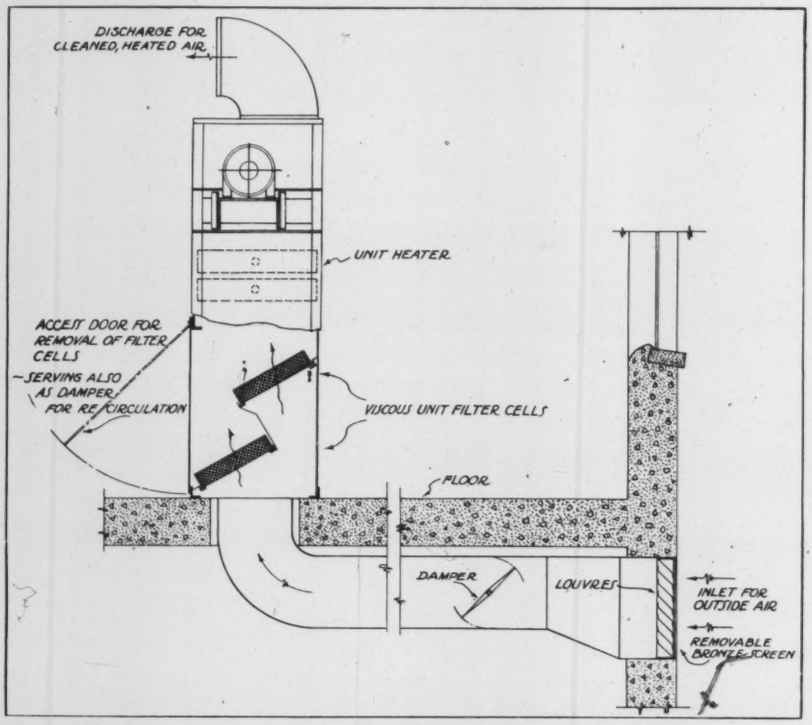
A new and outstanding example of a well planned unit heater installation is found in the new plant of the Campbell Soup Company in Chicago. This plant consists of a group of large multi-story buildings, which are heated and ventilated almost entirely by unit heaters. The seventy-seven units required to do this work are distributed in groups over the various floors. An interesting feature of this installation is that a number of heaters are equipped with air filters of the unit cell type, arranged in two tiers in the base of the heater which has been fully enclosed for this purpose.

While the small heating cabinets placed in schoolrooms and offices have long been equipped with air cleaners in the form of small cells, we find in this installation for the first time —to the writer's knowledge — an extensive use of air filters in connection with the larger unit heater type. This represents a definite step forward in the tendency which is underway, to equip every supply fan with some kind of an air cleaning device. Already we find very few central fan systems that do not pass their air through a filter, before it is distributed throughout the building.

Another interesting point in this installation is that the unit heaters are provided with sheet metal ducts which connect the heater inlet to the outside air. A typical layout is given in the line drawing, showing how these ducts are placed so as not to obstruct any valuable floor space. As quite a few heaters are located in the middle of the workroom floor, the air inlet connection was dropped through the floor and connected with the outside wall under the ceiling of the room below. In some of the installations this arrangement was reversed, the heater being placed in the room above, discharging the heated air downward through the ceiling. Dampers are placed at a convenient point in every air inlet duct, permitting regulation of the amount of outside air taken into the heating unit. The filter cells are accessible through large doors, and can be removed easily when it becomes necessary to clean them and renew their adhesive film. These doors can also be utilized to serve as dampers for the admittance of room air for recirculation. This feature is also brought out in the accompanying line drawing.

We might call attention to the importance of cleaning not only the air taken in from the outside, but also of any room air if it is to be recirculated. It should be considered that room air is often contaminated to a greater extent than the outside air. While the dust load of the latter varies with the weather conditions and especially the wind-direction, room air is bound to contain considerable quantities of dust incident to the manufacturing process. We will also find in this air particles released from the clothes of the occupants as well as exhalations of the human skin and respiratory system. Often these impurities are more dangerous and require more careful straining through air filters than those coming from out of doors.

Taken by itself the application described above may appear rather unimportant. But, considered as one phase of the science of air conditioning, it furnishes some little food for thought. It indicates a growing tendency among engineers toward a recognition of the need for cleaning the air introduced into industrial plants.




PLAN FOR FILTERING AIR FOR UNIT HEATERS

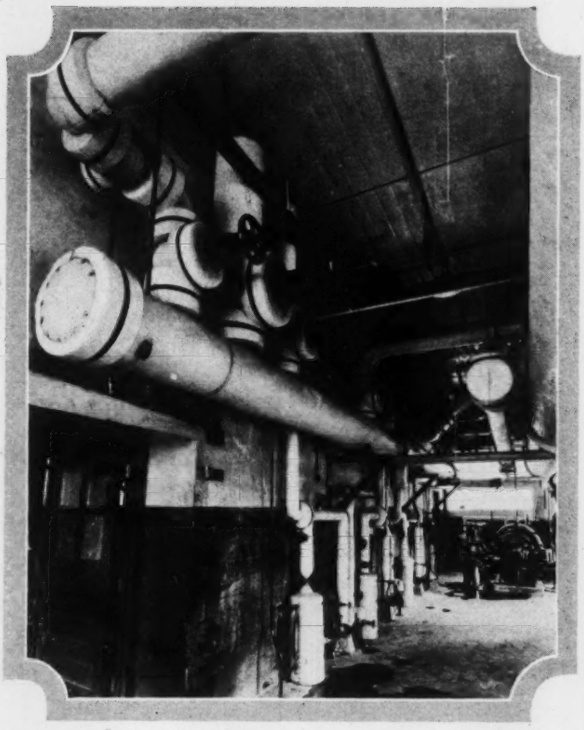


FIG. 1.—HIGH PRESSURE STEAM HEADER (WELDED CONSTRUCTION) IN PUMP ROOM OF INDUSTRIAL POWER PLANT

# Industrial Piping

*By* Albert W. Moulder

"INDUSTRIAL piping" as a term is a product of advertising. It was coined to explain the activities of a large national advertiser. Ten years ago no one ever heard of "industrial piping." Today it is the generally accepted term for one of the most vital parts of the whole industrial fabric.

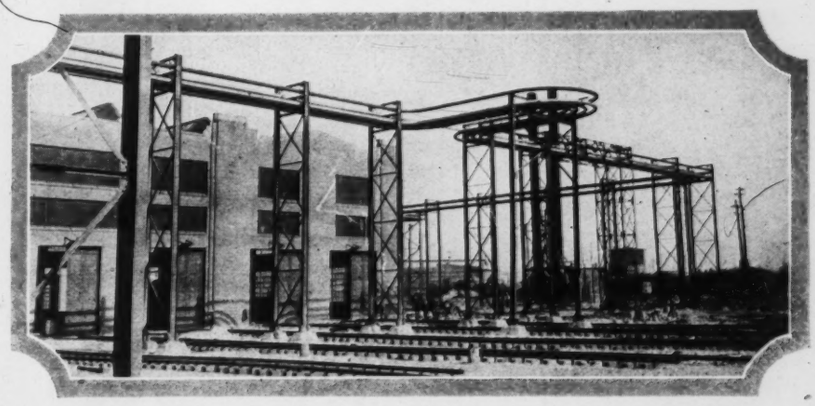
"Industrial piping" is doubtless the most important transportation system of industry. Instead of conveying goods, machinery and a variety of products, it conveys steam or liquid for power, heat or some other necessary adjunct to production. If American business would begin to think of piping in terms of transportation, it would be getting at the nub of what this article hopes to convey.

Transportation is a matter of getting anything, somewhere at the least possible cost. Cost in transportation is emphatically not initial expense, but the cost of maintenance, the cost of hauling, switching and unloading cars and a variety of other items, incidental to getting something, somewhere. No railway engineer would lay his rails without a careful survey and without regard for his road bed.

Too many pipe lines are comparable to heavy gauge rails laid on ties which bury themselves in swamp land. First cost in piping is the chief consideration of many men because they lose sight of the fundamental purpose of the piping.

In commodity transportation, freight and express rates are constant and tragic reminders of what cost actually is. In the industrial transportation field, as represented by a piping system, the freight or express rates are paid in the boiler house or pumping station and not distributed over the piping lines that in reality have so great a bearing on the tariff. The f. o. b. of rail transportation cannot be duplicated in industrial piping transportation lines. The man who ships heat or energy from a boiler to a machine through a pipe line pays the freight at every fitting, joint and bend. He pays for maintenance, depreciation and obsol-

FIG. 2.—OVERHEAD DISTRIBUTING LINES SERVING A GROUP OF LOCOMOTIVE ERECTION SHOPS



escence. And most of the time he buys his transporting pipe lines with his eyes tight shut to everything but first cost.

### Needed—A Pipe Consciousness

What industrial executives need is more pipe consciousness. They do not realize that they are buying a transportation system, because they cannot see inside the pipes and realize that actual transportation is going on. They see only static, uninteresting pipes and forget their real function, which is to convey steam, water, gas, oil or whatever it is that is being moved to its destination.

They see a power house or a pumping station and somewhere in the distance a machine or a process that must be served with energy, heat or cold. The invisible transportation system within the piping is too often not visualized—chiefly because it is in reality invisible.

### What Is Industrial Piping?

It is the purpose of this article to outline in some detail three basic factors which are common to practically all industrial piping installations. Which reminds me, by the way, that I have not yet said what is included in the term "industrial piping." If you think of any other piping than the following which is used in industry, why that's probably "industrial piping" too. Anyhow, "industrial piping" comprises at least the following:

Power plant or boiler house piping
Steam distribution piping
Heating steam piping
Condensate piping
Hydraulic piping
Chemical piping
Compressed air piping
Gas piping
Oil piping
Refrigeration piping

## Pipe Sizes

The first consideration in any kind of piping is size. In every pipe line, no matter what it is to carry, there is an economical size which should be accurately established if there is not to be a waste of one kind or another.

Technical knowledge and long engineering experience are required to determine exactly the most economical size of any pipe line. That an employe, with no more than a long practical experience in piping installation work, or some local contractor, with perhaps no more than a general plumbing experience, is not always qualified to do the work of a consulting engineer is not his fault. It is remarkable that his practical experience is so good a substitute for engineering training. With such experience he is usually able to produce lines that deliver the goods, even though such delivery is sometimes too expensive due to oversized piping and consequent heavy thermal losses.

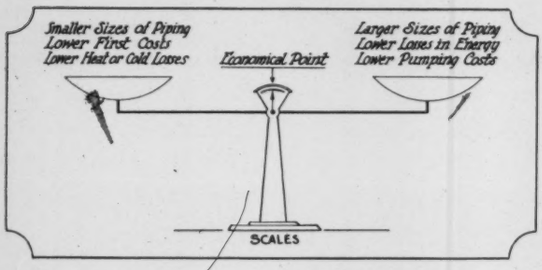



Fig. 3.—There Is an Economical Point at Which Lowered First Cost Must Be Outweighed by Loss of Energy

### Chiefly Problem in Frictional Resistances

Chiefly the calculation of pipe sizes is a problem in frictional resistances. In other words, as shown in the sketch, Fig. 3, there is an economical point at which consideration of lowered first cost and line losses, due to heat or cold radiation, must be outweighed by loss of energy or cost of pumping due to increased frictional resistance.

Calculated velocities are too often the measure by which sizes of piping are determined or are the excuse for the "jumping off" place, for the reason that an equal velocity has been previously used by "so and so" under similar conditions and proved successful. Thus, often through sheer daring to take a chance on a little higher velocity, these velocities have been stepped up slightly from time to time until we have reached a point where much more economical pipe sizes are used than were in vogue some few years ago.

As a matter of fact, in most problems, velocity may be neglected as a factor, as it only becomes necessary to consider it in those comparatively few cases where a "critical" or "terminal" velocity may be reached. This is met, for example, in steam distribution where condensation is carried in the same piping with the steam, and where it is necessary to drain this condensation back against the flow of steam. If velocities beyond those pretty well defined limits known to heating engineers as "terminal" are exceeded, water hammer will result.

### Calculating Economical Pipe Sizes

As an illustration of how an economical pipe size may be calculated from frictional resistance, assume a problem where a steam line is to be installed under the following con-

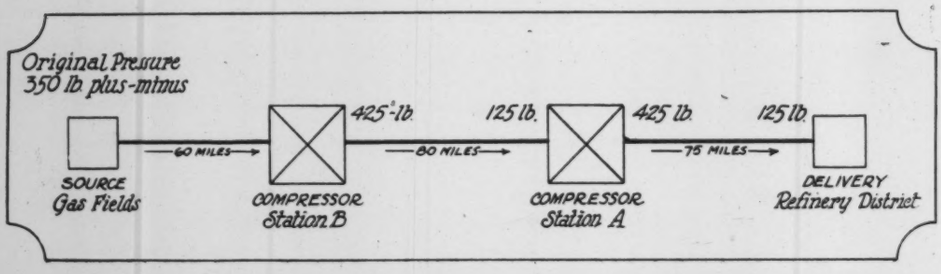



Fig. 4.—How Gas Is Delivered 215 Miles From Its Source at Desired Pressure

ditions:

| | |
|---|---|
| Initial steam pressure, lb. saturated | 100 |
| Required to deliver, lb. steam per hour | 6,000 |
| The maximum possible future load must always be safely considered; therefore, add lb. steam per hour | 6,000 |
| Total, lb. steam per hour | 12,000 |
| Distance from source of steam to point of delivery, feet | 800 |
| Allowance in equivalent feet of pipe for elbows, bends, turns, etc., feet | 200 |
| Total equivalent length, feet | 1,000 |

Using the formula $W=87\sqrt{\frac{WPd^5}{h\left(1+\frac{3.6}{d}\right)}}$ for resistance, which is used as a basis for most steam tables and charts, we get roughly the following results:

4-in. pipe—41.0 lb. total drop in pressure.
5-in. pipe—11.80 lb. total drop in pressure.
6-in. pipe—4.40 lb. total drop in pressure.
8-in. pipe—1.00 lb. total drop in pressure.
10-in. pipe—0.30 lb. total drop in pressure.

Obviously, for this particular example, where continued loss of heat is a factor, the use of larger than a 6-in. pipe will certainly increase first cost, with scarcely any gain in energy saved. In other words, after the 6-in. size is reached there is nothing more to gain by installing a larger size. There are even cases in which, if only reduced pressure steam is required at the delivery end of the line, the 4-in. line would certainly be the economical size to install.

This would hold true where a high pressure transmission line is installed to convey steam to a building for the sole purpose of furnishing steam through a pressure reducing valve to a low pressure heating system. There are thousands of industrial plants where this condition exists and it is safe to say that most of them have transmission lines supplying

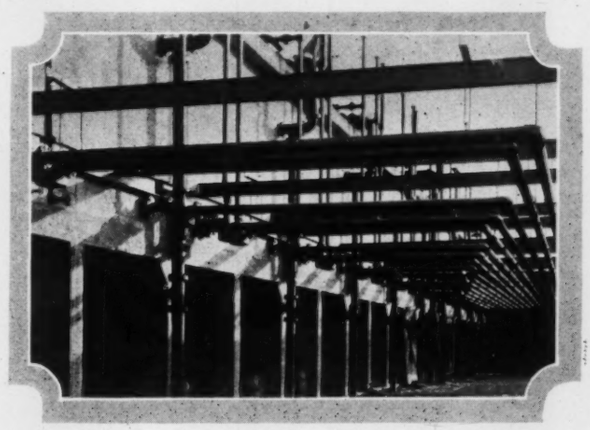


Fig. 5.—A Section of Industrial Piping Which Is a Part of an Installation of 69 Miles of Piping in an Oil Refinery

steam which are far above the economical size, and many of them might well afford to change them if the facts concerning the heat losses with relation to the economical sizes were recognized.

There is a further illustration of this point.

### Calculating Heat Losses

Roughly, the calculations covering relative heat losses in this example are as follows:

10-in. pipe=2.7 sq. ft. per ft. of length, or 2,160 sq. ft. surface

4-in. pipe=1.1 sq. ft. per ft. of length, or 880 sq. ft. surface

Difference 1,280 sq. ft. surface

Sq. ft. surface (T—To) K x 30 per cent=B.t.u. loss total per hour.

T=temperature in steam pipe.

To=average temperature surrounding pipe.

K=B.t.u.'s sq. ft. per degree difference in temperature.

30 per cent=factor discounting above for average insulation conditions.

1,280 sq. ft. (375-50) 2.0 B.t.u.'s x 30 per cent=249,600 B.t.u.'s per hour.

This figure reduced to pounds weight of steam per day equals approximately 6,000 lb., which, estimated at a value of $1.00 per 1,000 lb. (which is considerably less than average selling price by public utility concerns selling steam)=$6.00 per day.

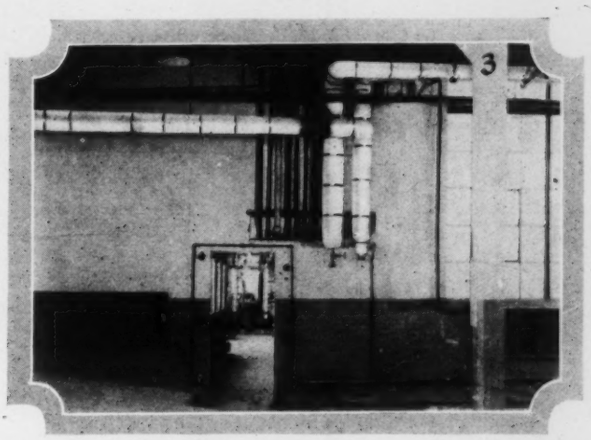
If the line is in operation only during the heating season, which, in our average climate, is usually estimated at 210 days, this would, therefore, represent a total annual waste of $1,260, or a 15 per cent gross return on an investment of approximately $8,000.

It is impossible to estimate arbitrarily whether this amount would pay for the installation of a 4-in. line, 800 ft. long, because obviously that would depend upon too many variable conditions. However, for the purpose of our example, we may assume that in considering a new installation, the relative cost of the 4-in. line to that of a 10-in. line would bear some relation to the weight of the two pipes, which would be:—4-in. — 10.79 lb. per ft., 10-in. — 40.48 lb. per ft. Certainly, the cost would be somewhere near double in the one case what it would be for the other and with proportionate variation for the intermediate sizes.

### Economy Through Proper Design

While this method of calculating pipe sizes may seem to be particularly applicable to the design of

Fig. 6.—A Number of Industrial Pipe Lines Entering Factory Building From Boiler and Pump Room. Includes Hydraulic Piping, High Pressure Steam Piping, Low Pressure Steam Piping, High Pressure Air Piping, Low Pressure Air Piping, Cooling Water, and Condensate Piping



long transmission lines, which is true because of the relative importance from the standpoint of first cost, nevertheless in supplying steam over short distances such as in power plants or boiler houses the same method of calculations will result in a decrease in sizes of piping which will be even more pronounced.

The writer recalls reading a book some ten or

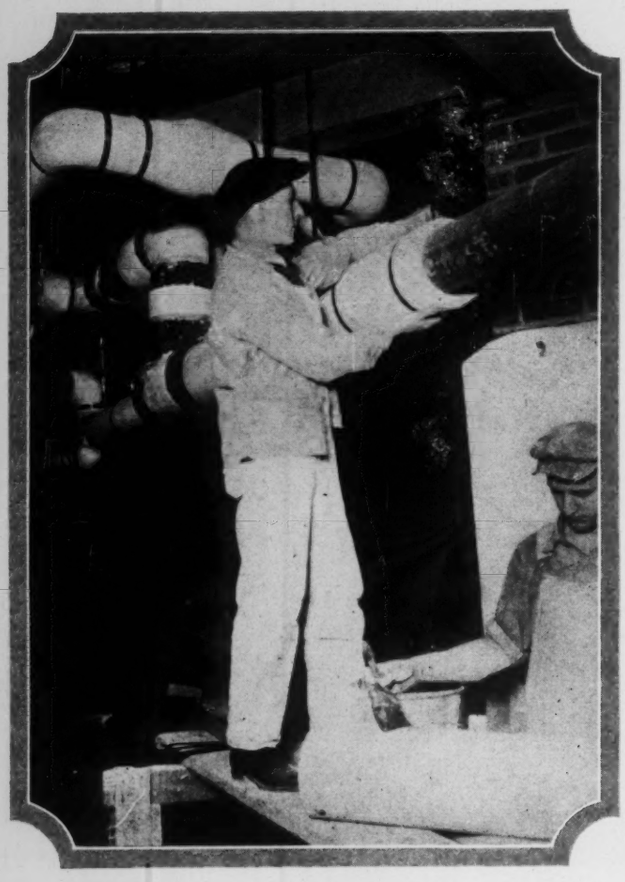


FIG. 7.—INSULATING PIPE LINES IN A NEW YORK HOSPITAL

twelve years ago on the subject of "Steam Piping" by A. Langstaff Johnston, Jr., which ably advocated this method of pipe size calculation. This book was loaned to a friend who is architect and consulting engineer for one of the largest industrial concerns in this country with the result that when he designed its next power plant he agreed to try this method out to the limit. The result was that in a power plant where two large water tube boilers, each having 6-in. nozzles, and two poppet-valve type engines, having 7-in. and 9-in. nozzles respectively, were installed, the largest size pipe in the high pressure steam line was the 4-in. header, and the leads to boilers and receivers at the engines even smaller.

This piping system has an almost negligible drop in pressure and has been carrying the load perfectly for over 10 years. This plant was only recently written up in one of our technical papers by the operating engineer and was cited as a model of economical operation. The failure of the author of the paper to note or mention the fact that his piping system is unusual, however, is possibly due to the fact that he did not realize this fact. Perhaps some small credit may, however, be attributed to this fact as contributing to the overall efficiency and low first cost of the plant.

Of course, many consulting engineers, especially those responsible for the design of our large modern public utility power plants, are doing relatively in their much larger stations just this same thing, but in industrial plants this degree of economy through proper design is much less frequently observed.

This calculation of pipe sizes by frictional resistances is applicable to the transmission of gases, liquids and, in many cases, to chemicals as well as to steam, the only difference being that in the three former cases the result goes back to pumping cost instead of fuel.

### 215-Mile Pipe Line

Probably our most noted examples of care in the figuring of such problems have been in connection with the installation of gas transmission lines between points a great distance apart. For example, the pipe line extending from the natural gas fields in northern Louisiana to a refinery district in southern Texas covers a total distance of 215 miles.

The pressure at the point of origin is variable but is sufficient at all times to convey the gas economically through 18-in. mains to station B, located approximately 60 miles away. (See Fig. 4.) Here compressors are installed which boost the pressure to 400-425 lb. which is sufficient to carry it economically to station A located approximately 80 miles distant. Here it is again passed through compressors and boosted to 400-425-lb. pressure and delivered to the

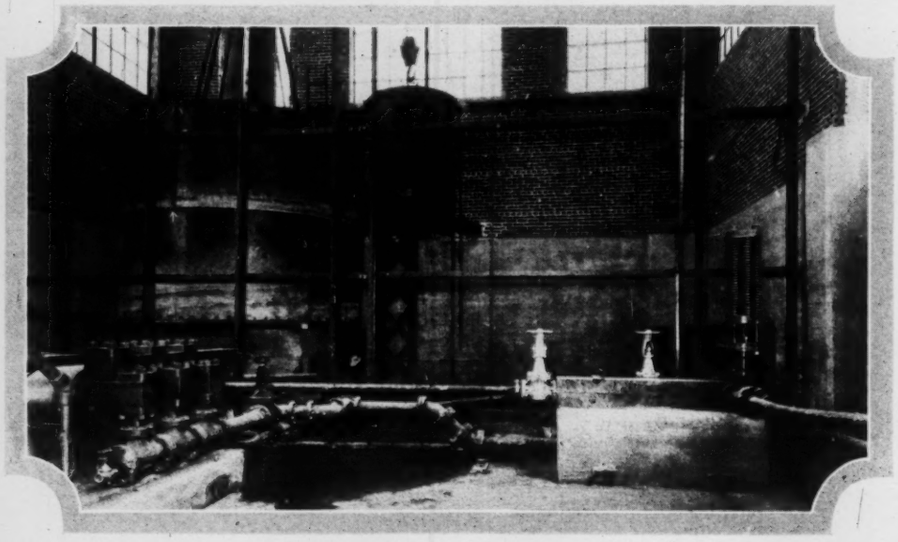


FIG. 8.—HYDRAULIC PIPING FOR 3,000-LB. WORKING PRESSURE. NOTE AT RIGHT, THE 12-IN. SQUARE BY 6-FT., 6-IN. LONG SPECIAL FORGED STEEL MANIFOLD, MADE FROM ALLOY STEEL AND DRILLED CONCENTRICALLY THROUGHOUT ITS ENTIRE LENGTH TO 3¼-IN. DIAMETER. ALSO THE 2½-IN. HYDRAULIC SPRING CUSHION SHOCK VALVE

discharge point 75 miles away at a pressure of 125 lb.

This line is delivering more than 40,000,000 cu. ft. of natural gas a day to an important American industry, and it will be apparent that before the tremendous amount of capital necessary to this great achievement was invested, able engineers calculated the economical size of piping, taking into account pumping (or compressing) costs, in proportion to first costs, so as to arrive at the best return on investment.

**Equally Applicable to Every Installation**

It is the writer's hope that this example, though extreme by its bigness, will serve to impress the fact that this same basic principle in design is equally applicable in a much smaller but proportionate sense to practically every industrial piping installation, even down to the circulating drinking water system which runs through the plant.

Data can be found in technical works which will permit practical application of these methods of calculating pipe sizes for most of the problems encountered in industrial piping.

# Materials

Once proper sizes have been determined, the next general problem is the selection of materials. Remembering always that every piping system is simply a transportation line, we have to consider strength, durability and maintenance, all of which must be weighed in the light of first cost. Each of these items must be viewed from the angle of the service the line is to perform. Just as is the case in determining proper pipe sizes there is always an economical standard in materials. To fall below that standard means waste through quick obsolescence or very high maintenance. To exceed greatly that standard means high initial expense which can not be justified through longer life or cheaper maintenance.

A Brooklyn bridge over a stream on some light traffic railroad would never justify itself if it lasted a million years. No more could you excuse a flimsy structure which frequently dropped freight cars into the stream beneath. By the same token you can not afford to have ordinary materials where severe conditions are imposed and yet you do not need expensive special pipe and fittings in pipe lines when only ordinary conditions of usage and service prevail.

The very rapid growth and development of American industry with processes undreamed of a decade ago have created many new problems in connection with the proper selection of materials. Steam pressures up to 1,800 pounds and temperatures up to 750 degrees have necessitated pipe joints of a strength and character which would have been sheer economic nonsense not so many years ago.

Fortunately, the selection of materials has been vastly simplified through standards set up by engineering societies and which are rigidly followed by manufacturers supplying such products.

It is notable to those of us who have, in one capacity or another, been connected with the great growth of the piping industry, that this very urge for piping materials which will economically serve these growing needs has resulted in the development and manufacture of many new products which are rapidly becoming common to us. A list of the various kinds of pipe used in large quantities today, which are just jotted down here, serve to show some special developments which, if used at all a few years ago, were merely laboratory products:

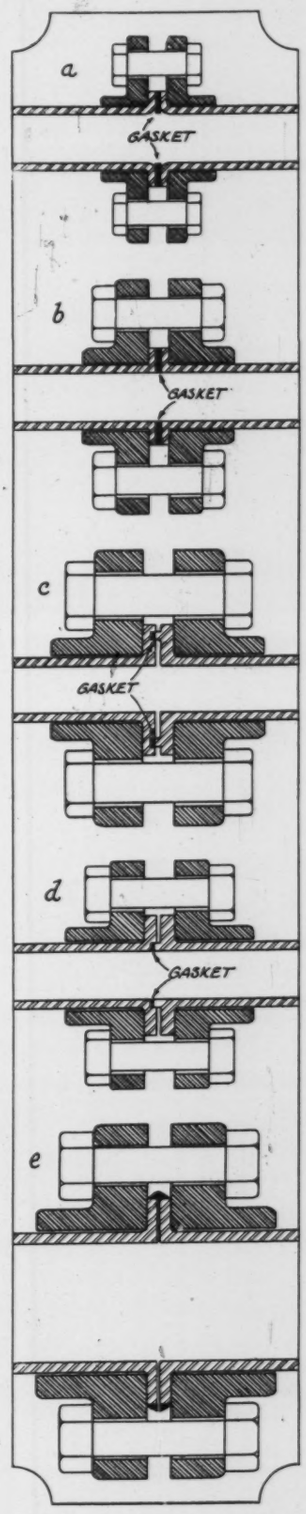



FIG. 9.—TYPES OF LAP JOINTS

(a) Original or present "competitive" type lap joint. Laps approximately 75 per cent of pipe wall thickness and machine faced in front (next to gasket) only.

(b) Improved type lap joint in use for high pressures and temperatures. Laps not less than 100 per cent of pipe wall thickness after machine finish back and front. Alloy steel stud bolts.

(c) Tongue and groove lap joint for high pressures and temperatures. Laps not less than 100 per cent of pipe wall thickness at thinnest point (bottom of groove) after machining back and front. Alloy steel stud bolts.

(d) Male and female lap joint for high pressures and temperatures. Laps not less than 100 per cent of pipe wall thickness at thinnest point after machining back and front. Alloy steel stud bolts.

(e) "Sarlun"—(Weld-seal) lap joint. Laps not less than 100 per cent of pipe wall thickness at thinnest point after machining back and front. Alloy steel stud bolts. Weld (no gasket required).

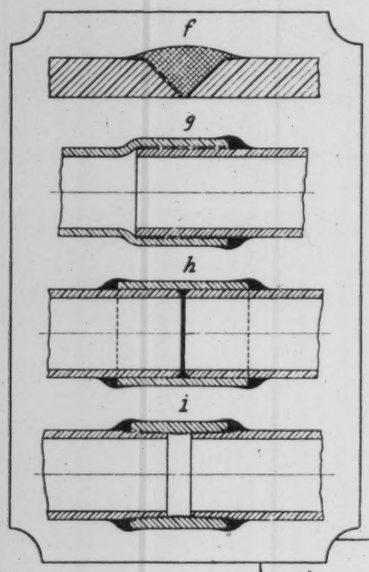



FIG. 10.—VARIOUS TYPES OF PIPE WELDS
(f) Butt weld, (g) Cup weld, (h) Sleeve weld, (i) Screwed coupling, back welded.

*Steel Pipe*—Continues to be our main product for most services.

*Wrought iron pipe*—Recommended by its makers where corrosion is a factor, such as in condensate, heating piping, boiler feed water lines, etc.

*Seamless steel pipe*—Now used extensively for the high pressure steam power plant piping. Recommended by codes for steam pressures 400-lb. and higher.

*Alloy steel pipe*—Now made in several alloys combining copper or other metals into products designed for use where corrosion or erosion is a factor.

*Brass and copper pipe*—Pipe of copper or brass mixture is being used extensively today where economy in the long run can be shown, proving owners are becoming more and more interested in final economy.

*Cast iron pipe*—Used for outside water piping, drain piping and many ordinary services as always.

*Alloy cast iron pipe*—Cast iron pipe alloyed with other metals is now being produced so that it can be threaded for use with regular cast iron screwed fittings. Designed for installation where an especially non-corrosive and non-erosive material is required and also for some acids. Some alloy cast iron pipe, fittings, valves, etc. (not threaded) are recommended by their makers for practically all acid and alkaline conditions.

*Aluminum pipe*—Recommended by its makers for its light weight, flexibility for bending and non-corrosive feature.

*Wood pipe*—Used in certain process piping involving strong solutions, both alkaline and acid.

*Hard rubber pipe, rubber lined pipe*—These products have also become widely used in certain process piping where strong solutions of acids are encountered. Also for abrasive solutions and dry abrasives.

*Lead pipe*—Used in process piping where strong solutions of acids are encountered.

It is interesting to note that, in connection with practically all of the special piping, such as aluminum, rubber and some of the alloy pipe, there are now available fittings, valves and even specialties to match up with the pipe so as to make a continuous line of the materials for a given process.

### Fittings, Valves, Specialties

It is impossible to cover even in a general way this item of fittings, valves, specialties, etc. They are all a very necessary part of industrial piping, but any one of them might well require an entire article of its own.

It is in pipe joints that we encounter a most disturbing element in our estimates after we have selected basically proper materials. Pipe joints are an important factor in the final delivery cost of a piping system because they affect upkeep, maintenance and even the very life of the piping.

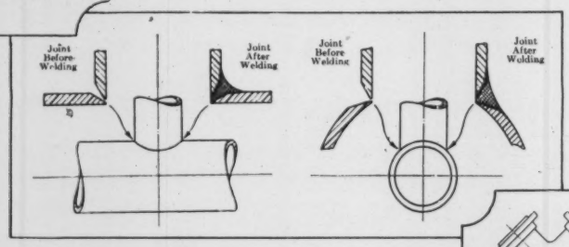
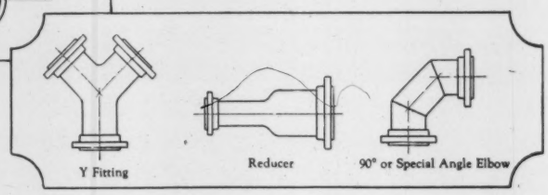



FIG. 11.—(LEFT) WELDED NOZZLES OR OUTLETS. FIG. 12.—(BELOW) WELDED FITTINGS




### Selecting Type of Pipe Joints

In selecting the type of pipe joints for a given service several factors must be considered:

1. Joints which will make up tight.
2. Permanence of tightness.
3. Labor cost.
4. Ease of disassembly for changes.
5. Readiness with which materials or preparation may be obtained.
6. First cost.

### Threaded Joints

Aside from certain cast iron and wood pipe lines, most piping lends itself to the use of threaded joints. Not so many years ago, this was practically the only known type of pipe joint for steam piping and similar services. Increased pressures in all kinds of piping, but particularly steam piping, the demand for permanence, plus the necessity for the lowest labor cost have necessitated the development of other types of pipe joints.

Screwed pipe joints for most ordinary services are still used very largely and, even for steam or lines alternately to some degree hot and cold, these types are economically satisfactory. The greatest trouble is with the larger sizes where high temperature conditions are present. Under such conditions, cast iron flanges or fittings will "grow" so that eventually they will become leaky.

By "growth" of the cast iron is meant expansion of the metal because of heat and failure to return to

its original diameter. Steel pipe so heated does return to its original diameter after it cools. The result of "growth" is that a slight space is left between the pipe and the flange or fitting with resultant slight leakage. This starts a corrosive or erosive action which gradually becomes worse.

### "Lap" Joints

Some thirty years ago, the Van Stone joint, or what is more commonly referred to as a "lap" joint, was developed and brought out. This joint, practically in its original conception, adequately met maximum conditions for many years. It has been succeeded by many improvements and variations all made necessary by the advent of higher pressure and temperature requirements. See Fig. 9—*a, b, c, d, e.*

Lap joints of one type or another cover our basic requirements, numbers 1, 2, 3 and 4, probably better than any other type of pipe joint. Only items 5 and 6 are sacrificed to some extent, because such joints are slightly more expensive and can only be obtained from pipe fabricating shops equipped with machinery for properly making this type of joint.

It is interesting to note that while lap joints were developed for and made exclusively in steel pipe for many years, recently processes have been developed for making similar joints in wrought iron, brass or copper piping. This has not only promoted a broader use of lap joints but, to some extent, has broadened the use of non-ferrous and non-corrosive pipe by the very fact that this more permanently tight type of joint is available.

### Welded Joints

Welded pipe joints, properly made, are the answer to all of our six basic factors with the possible exception of the last—first cost. Even in that particular they are often found to be as cheap, if all the items entering into a finished joint are considered.

Welding is applicable to practically all kinds of piping material, including not only steel and wrought iron but even cast iron, brass, etc. And welded pipe joints have a remarkably good record. The writer has had occasion to state a number of times and can repeat today that there has never to his knowledge, or even hearsay, been a failure in a welded pipe joint which was made properly.

It is not uncommon for concerns who have followed the development of pipe welding, and have properly trained pipe welders in their employ, to furnish welded piping for working steam pressure up to and including 400 lb. and carrying temperatures, including superheat, up to 750 degrees. In many instances, welded steam headers made by both the forge and hammer welding process or by one of the several autogenous processes are furnished for even higher pressures. In Fig. 10—f, g, h, i, various types of pipe welds are shown.

It is for the industrial executive, either directly or through some contact with the experienced engineer, to determine for his particular problem:—first, what are the economical materials to use; and, second, what is the economical manner in which to assemble these materials?

## Supports

Perhaps the most significant thing in the whole field of industrial piping is that those who have given the greatest thought and study to the matter of hanging or supporting pipe lines have set up factors of safety on hangers and supports which are probably greater than in any other items in the whole field of building or bridge construction. For example, the Power Piping Society, voicing the experience of practically all of the country's largest piping fabricators and contractors for the most important power piping installations, recently included in its standard

FIG. 13.—PIPING IN TUNNEL EXTENDING FROM POWER PLANT AND PUMP HOUSE OF LARGE INDUSTRIAL PLANT TO FACTORY BUILDING. INCLUDES PIPE LINES FOR VARIOUS PROCESSES AS WELL AS HIGH AND LOW PRESSURE STEAM LINES. ALL WELDED CONSTRUCTION

specifications:—"All pipe supports and hangers shall have a factor of safety of not less than 12 to 1."

It is not strange that it should have done this. The strange thing is that ordinarily the hanging or supporting of piping is given no thought at all. Often one might suspect that as far as adequate specifications on pipe hangers and supports are concerned, the writer of these specifications expected pipe lines to support themselves in some miraculous manner in utter defiance of the immutable law of gravity.

### Basic Considerations in Designing Hangers

It is only possible in the space that is left to endeavor to cover briefly the basic governing considerations which must be taken into account in designing hangers for industrial piping, and to impress upon the owner or his engineer the supreme importance of knowing how the piping is to be supported. In training engineers who have had to do with the design or installation of piping, one of the first, and probably the most oft repeated instruction in the writer's experience, has been:—"Never show a pipe line on a plan until you know how it is going to be supported." If this item is neglected, the chances are that the piping will be installed in an economically wrong position, or when the workmen get around to making the installation it will not be located where planned at all, with consequent "extra" costs for changes, wasted materials and other complications.

There are three basic factors involved in this problem of properly hanging or supporting piping systems:

### Safety

1. The first consideration in the design of supports must necessarily be safety. This involves much more than simply a definite factor of safety to total weight. Supports must be located closely enough to prevent sagging. For steam and other hot lines, the problem of expansion and contraction with ample anchorage provisions must be met. In such cases the piping will probably be insulated and, then, the question of how the insulation can best be worked about the supports is important. If even this small item is neglected the efficiency of the insulation may be greatly impaired through convection as well as radiation.

In nearly every case, safety, as applicable to the supporting of industrial piping, includes consideration of the vibration to which the piping is subjected. The absorption of this may, in extreme cases, require that springs or other devices be embodied into the design. Even under most harmless appearing conditions, however, provision for locking the hangers after installation so that vibration can not slacken off the parts is imperative.

### Adjustability

2. The second basic factor involved in the design of supports for industrial piping is adjustability. A specification which admirably covered this feature was included in the recent proposed Ohio State "Code for Pressure Piping" and read:—"Hangers for pipes larger than 3½-in. shall be capable of screw adjustment after erection." A screw adjustment of some sort will usually provide the best means of properly distributing the load over a number of hangers. It is difficult to install supports before the pipe is put in place so accurately as to levels that each hanger will be doing its part in carrying the total load. Therefore, the most practical solution is to provide means whereby the workmen can adjust these hangers after the piping is in place. It is not uncommon to find pipe lines installed in such a manner that only every third or fourth hanger is doing any work.

If this adjustability feature is thus adequately provided for to take care of proper installation conditions, it will automatically provide for readjustment to compensate for sagging or irregular settling of the structure to which it is attached.

### Cost

3. The third basic factor involved in this hanger problem is cost. Obviously, cost in this connection must take into account chiefly the labor cost of installation. Therefore, every dollar spent in good design is amply repaid severalfold in the total cost of the installation.

Proper piping engineering, therefore, must include a consideration of this part of the total problem. It is next in importance only to the other two basic factors which are common to every industrial piping installation; i. e., economical pipe sizes and selection of proper materials.

Thus, we have endeavored to establish an appreciation of the importance of proper piping and to present its three basic principles.

## Piping Is a System of Transportation

*"If American business would begin to think of piping in terms of transportation, it would be getting at the nub of what this article hopes to convey. Industrial piping is doubtless the most important transportation system of industry. Instead of conveying goods, machinery and a variety of products, it conveys steam or liquid for power, heat or some other necessary adjunct to production.*

*"The F. O. B. of rail transportation can not be duplicated in industrial piping transportation lines. The man who ships heat or energy from a boiler to a machine through a pipe line pays the freight at every fitting, joint and bend. He pays for maintenance, depreciation and obsolescence. And most of the time he buys his transporting pipe lines with his eyes tight shut to everything but first cost.*

*"What industrial executives need is more pipe consciousness."*

# HEATING IN 1940

shows many developments in the practice as known today, according to

## *SAMUEL R. LEWIS*

who writes of heating from the viewpoint of ten years hence. Better insulation, automatic firing devices, automatic control of heat and cold, changed types of radiation are a few 1940 heating commonplaces

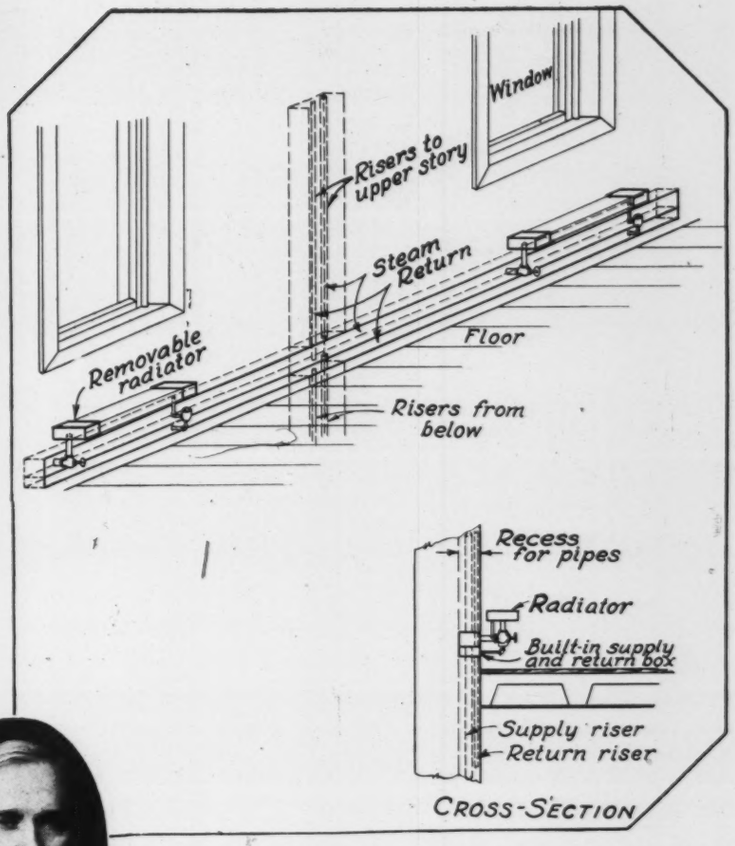



FIG. 1.—THE 1940 METHOD OF CARING FOR RUNOUTS TO RADIATORS FROM RISERS

THESE random notes were found, in the year 1940 A. D., between the leaves of an old book. Many of the circumstances recorded were common experiences in 1930, and the buildings in which they were operating or the basis for their development could even have been cited in 1929.

I wish that I could weave a tale like that of the Connecticut Yankee around them!

One of the spectacular developments of the present day* is the co-operative apartment house, in which there may be hundreds of homes.

The Colossus, in Chicago, is one of these. It houses one hundred and fifty families. It was built in 1936. It is heated by three boilers which are arranged to transfer the heat from the combustion of bituminous screenings. These boilers look more like huge ice boxes than they look like heaters, as they have enameled steel sides and tops and are not hot to the hand.

There are two coal-pulverizing machines on steel tracks in front of the boilers, arranged so that either pulverizer may serve any boiler, electric and coal services and ducts being left for quick flexible connection in each

*In order to depict more clearly the trend of thought in heating, the author of this article writes in the past rather than in the future tense, and looks back upon this decade from the vantage point of 1940; and it is the year 1940 to which he refers when he mentions, "The present day."

FIG. 2.—BOILER FRONTS AT LEFT; COAL BUNKER AT RIGHT; UNIT COAL PULVERIZERS AND SPOUTS AT LOWER RIGHT

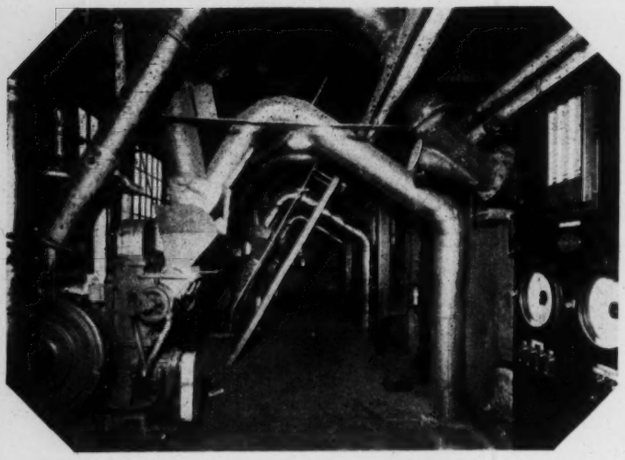


FIG. 3.—A PULVERIZED-COAL-BURNING HEATING PLANT. THE FIRST GOOSENECK CARRIES HOT AIR AND COAL INTO THE FURNACE. THE SECOND GOOSENECK CARRIES HOT AIR FROM THE FURNACE WALLS TO THE PULVERIZING MACHINE. TO THE RIGHT MAY BE SEEN THE DIALS AND GAUGES

location. The pulverizers are so reliable that a third one for the spare boiler is unnecessary. The coal powder is blown into the water-walled combustion chambers, which also have air-preheater surfaces, and the combusion conditions within the boilers are all indicated by dials and gages and are controlled automatically.

Coal handling, from the time the trucks dump into the hoppers under the rear sidewalk until the coal reaches the combustion chamber, is entirely mechanical, and the average temperature of the products of combustion leaving the boiler is well under 350 degrees. The ashes are a powder so free from carbon that they do not stain one's hands. They are removed by a metallic vacuum cleaner, which delivers them into a separator from which they pass to covered steel cans.

### No Chimney and No Smoke

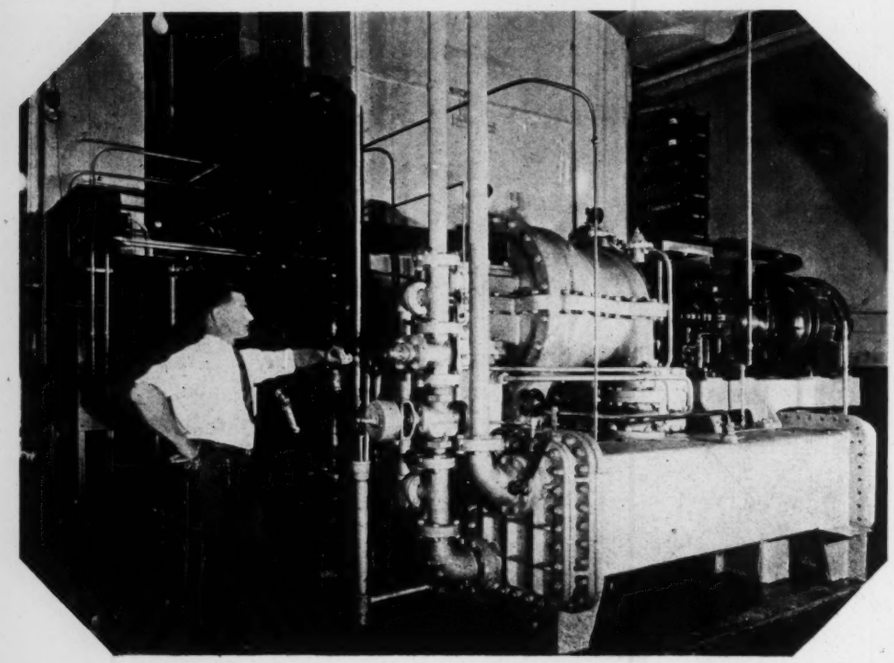
There is never any smoke.

One custodian, occasionally checking up the dials, is required, and the enormous chimney of former days, with its wasteful usurpation of floor area through the entire fifty stories of the building, and with its incidental overheating of adjacent spaces, has been reduced to a conduit little larger than the main steam riser.

Steam is used for heating, but this varies in temperature from as low as 140 degrees up to a maximum of 200 degrees, never reaching atmospheric pressure, all under the influence of the master regulators placed out of doors, which control the intensity of the heat in the radiators in proportion to the wind and weather conditions encountered by each facade of the building. The master regulator even takes into consideration, with its automatic zoning, the lower areas, wind-shielded by adjacent structures, and the more exposed upper stories.

In the apartments we find the distributing mains of the new two-compartment, rectangular tubing developed in 1934, built into the walls, with welded-on outlets appearing under the windows for radiator connection as desired by changing conditions. (See Fig. 1.) We

FIG. 4.—THIS COMPARATIVELY SMALL REFRIGERATING MACHINE (PAINTED WHITE) SERVES THE AIR COOLING OF A LARGE OFFICE BUILDING



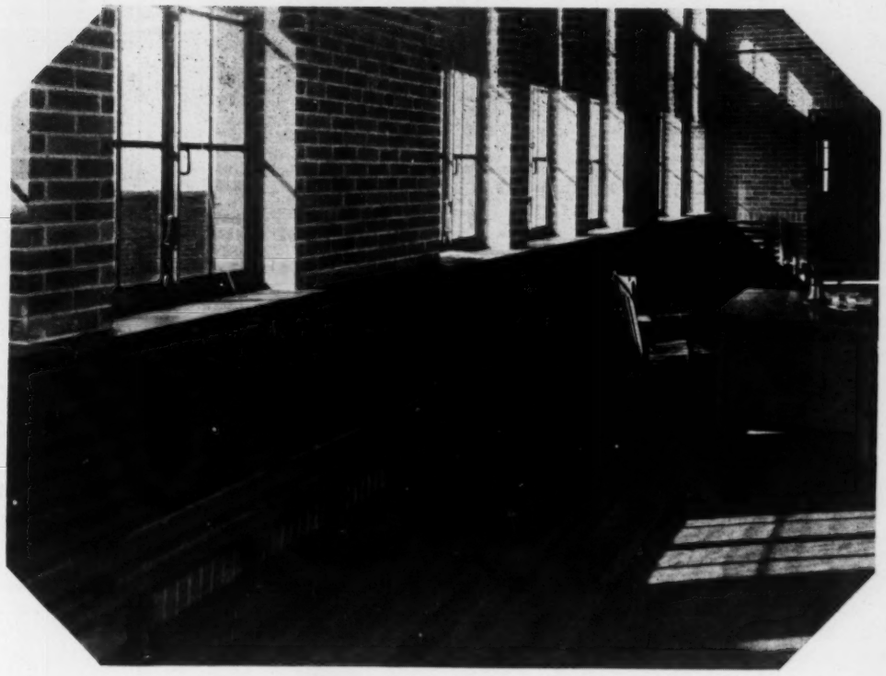


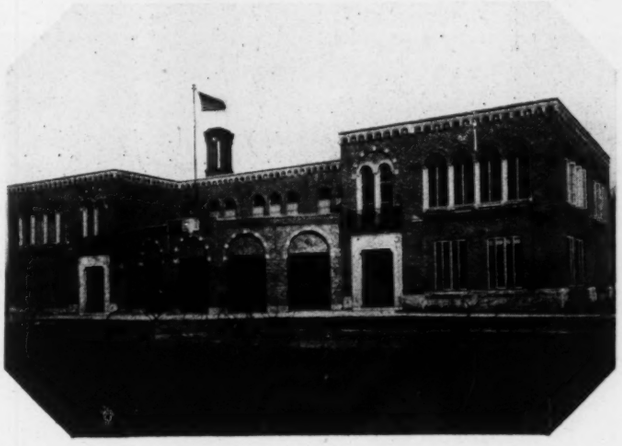
FIG. 5.—IN AN OPEN AIR SCHOOL THE MANIFOLDS ALONG THE WALLS FEED THE WELDED BETWEEN-FLOOR STEAM PIPES

learn that many of the small compact radiators are removed in summer and stored in the basement.

In the sleeping rooms all radiators are recessed, with sliding panels in front of them, which close and open on pressing a button. Thus, the old-time bugaboo of not being able to go to sleep until the room cools down is well met, since the radiator can be boxed up in its warm chamber, while the window can be opened wide for cool sleeping. In the morning, when the windows are closed, one presses the button and the radiator, already hot, makes quick work of warming up the room.

In a few of the rooms, using the admirable small motor mechanisms produced around 1928 for operating dampers, valves, etc., they have arranged for two windows and the radiator shutters to be inter-connected, and a silk covered cord is carried from the wall-button to the head of the bed. Thus, the occupant may open the windows and close the radiator shutter after he is tucked in bed, and may reverse the operation in the morning. This is, of course, old stuff, for the idea was invented many years earlier by ingenious boarding school boys who used ropes and pulleys.

FIG. 6.—THIS OPEN AIR SCHOOL IS DESIGNED NOT SO MUCH FOR OPEN AIR, PER SE, AS FOR UNUSUAL NUTRITION AND OBSERVATION OF SELECTED PUPILS. ALL WINDOWS, HOWEVER, ARE ADJUSTABLE AND USUALLY ARE OPEN, AND ALL FLOORS ARE HEATED BY STEAM PIPES BETWEEN THE JOISTS



### The 1934 Unit Heater

In the living rooms there seem to be no radiators. We note, however, a handsome pottery vase and are surprised to find a strong current of warm air issuing from it. It is the 1934 unit heater, having its own electric fan and steam radiator, all connected into the wall services by a flexible hose. There is no noise, and each heater carries its own automatic control mechanism.

Stepping into the kitchen-corridors, we are impressed by the absence of any odors to advertise what our neighbors are having for lunch. Inquiry develops that the chimney-tendency of lofty buildings has been recognized, and that we shall find a fan and heaters with ducts which make a clean air plenum chamber out of the elevator and stair shafts of this building, to the end that any open kitchen door will insure a draft of comfortable, sweet smelling air into, instead of out of,

each kitchen. (They *will* leave these doors open in spite of results!)

### The Laundry on the Roof

We were invited to inspect the laundries. On looking for them, in their usual basement-location, we were agreeably disappointed. We finally found them on the roof! Here, in high, sunny, airy rooms, separated only by screens, we find a group of washing machines, each with its various appurtenances. In another part of the room there is a group of dryers, though sunshine and its attendant bleaching and purifying influences are available in dry weather. In a nearby area are the ironing machines. The laundresses sing about their work, and we do not wonder why help was hard to keep in the old days of laundry dungeons with their heat and smell and dampness.

This laundry, in addition to improved sanitation, was so arranged that the tubs and washers could be used by some one else while the original laundress had passed on to the dryers or ironers, in contradistinction to the situation in the usual apartment building laundry, where the equipment not in actual use, owing to its location, necessarily was idle.

### Radiators Put in Storage for the Summer

We then visited the Hopewell Towers, an office building of 1936. There was little here which had not been observed in the heating equipment of the Colossus Apartments, except that all radiators were of the removable type, and were stored in the radiator room during warm weather, just as we store away our summer desk fans in winter.

The cooling equipment here was interesting, however, for the entire building has refrigeration-air-cooling.

Each story is well isolated from all other stories by very tight revolving doors, as found necessary, due to the tendency of the heavier cool air to run out and down.

The air ducts are built into the ceiling construction of each story, with a rotary electric distributor in the center of every bay. We used to see these in the New York Central dining cars. The ducts are surprisingly small, as is possible due to the mechanical mixing of the comparatively small volume of quite cool, very dry air with the warmer room air. Recirculating or return air ducts come from near the columns, also at the ceiling.

### Insulation Used in Office Buildings

No attempt is made to keep the temperature of the air in the rooms down to the old line comfort-zone temperature, but experience has proved that a reduction of from eight to ten degrees below the outside summer temperature, whatever this may be, with a substantial reduction in moisture, renders the tenants very happy.

We found no unleased quarters in the Hopewell building. All of the windows are double, and all of the outside walls of this building are sealed with bituminous-like compound to reduce infiltration. They are lined, also, under the plaster, with a highly efficient insulating material.

### Indoor Temperatures Reduced by Roof Sprays

We observed here for the first time the roof and wall sprinkling system. There are, connected with the house pumps, a series of small, unobtrusive, brass spray heads with which, on sunny, hot, summer days, a fine spray of water can be used to wet down the entire exterior surfaces of the building. The results, due to cooling by evaporation, are said to be remarkable, sometimes causing a reduction of interior temperature equal to that gained by the refrigerating plant. The sprays operate intermittently, and are so regulated that they merely dampen the surfaces, then stop for some time, until evaporation has removed the water. No water ever runs off to the gutters.

A little later in the season we took a parlor car for Kansas City. It was a very hot day. We had anticipated no pleasure in this day-run, well remembering the usual torture of riding in warm weather in a steel car.

We found the car delightfully cool, however, as it had been standing under the station sprays now provided for evaporator pre-cooling in the Union Station.

To our surprise the car stayed cool, and we found this to be due to the continued evaporation on the roof, of a mere trickle of water maintained from a special tank which we noted was quickly refilled at each division stop. All of the transcontinental trains, we are told, have used this device in summer since 1936.

It was developed and perfected by the research laboratory of the American Society of Heating and Ventilating Engineers along about 1927.

### Dependable, Continuous, Automatic Heat

In Kansas City we inspected several of the new housing units near the air port. These are low-priced, individual houses and are designed for the ideal in low-

FIG. 7. — OUTDOOR REGULATORS WHICH CONTROL THE INTENSITY OF THE HEAT IN THE RADIATORS IN PROPORTION TO THE WIND AND WEATHER. TWO TYPES ARE SHOWN HERE

cost maintenance. They are heated by gas burning warm air furnaces, using electric fans for warm air distribution. Some years ago in a residence, one of these devices, after having been started, was sealed up for over fourteen months, insuring no possibility of human influence or adjustment. The heating apparatus functioned perfectly during the entire period, maintaining comfort throughout the house and keeping the temperature at around 68 degrees during all heating days, and at around 50 degrees at night, shutting itself down during the summer; starting itself in the fall. It maintained comfort-zone moisture, too, and burned low grade gas at a cost so low that it startled the neighbors.

Such devices are being introduced very widely in the latest phases of district heating, and district heating seems to be developing into heating by gas.

The losses in transmission, when district steam is used, handicap steam as a long distance heat-carrying medium. Hot water district heating is not so wasteful, but no approved scheme of metering this service yet has been devised. Gas, on the other hand, yields valuable by-products in its manufacture, has little loss in transmission, and can be metered.

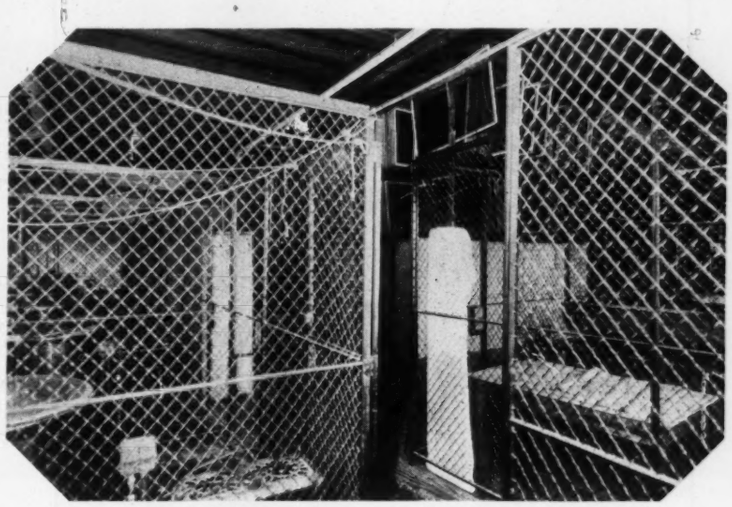


FIG. 8—THE ROOF LAUNDRY. OWING TO THE LIMITATIONS OF PHOTOGRAPHY, THE AIRY AND PLEASANT EFFECT OF THESE ROOMS IS DIFFICULT TO SHOW. THE WASHING MACHINES ARE AT THE LEFT, EACH WITH ITS TUBS AND GAS STOVE. THE DRYERS ARE IN THE CENTER DISTANCE, AND THE IRONING MACHINE COMPARTMENTS ARE AT THE RIGHT

Gas has another interesting feature. While steam and hot water carry heat for district purposes, they are not easily adapted to household refrigeration purposes. Electricity provides refrigeration, but it is still too costly for universal heat. Gas, however, serves efficiently for both heat and cold.

It is very evident that the gas era has arrived. The great gas mains bringing this modern fuel from the mine-top plants could be seen at many points along the railroad as we made our way back from Kansas City. The railroads, deprived of the milk of the ancient coal-carrying revenue, are rightfully allowed the carrier-toll for transporting the more efficient cream from this milk in the form of gas.

### They Heat the Schoolroom by Heating the Floor

We stopped at Columbus, Ohio, recently to visit a school. In this building we found that more attention than usual was paid to heat and air distribution. They heated the rooms largely by heating the floors. This was an old scheme. "Jim" Davis and I saw a plant like this in Gary more than twenty years ago.

The air supply for the Columbus school was introduced through slots in the window stools and along the outer walls. Comfort and increased efficiency were obtained due to the warm floors, with room temperatures many degrees below those to which we ordinarily are accustomed. The air entered the rooms where one would expect it, at the window ledges, and, as it swept the entire room positively on the way out, the "little Johnny" odors were noticeable by their absence.

### An Electric Steam Unit Heater

The gymnasium of another school which we visited, having plenty of windows, needed no mechanical ventilation, but was heated, except when there was to be a crowd of people, by electric steam unit heaters. These were of the very efficient type which long ago was adapted from the cooling apparatus for cylinder jacket water used on automobiles.

The heat transfer agencies in this case were arranged each with two thermostats. Thermostat number one controlled a valve on the steam supply pipe leading to the heater, and when it was cool, permitted steam to reach the heater. When steam had warmed the radiation in the unit and had reached the return pipe thereof, it warmed another thermostat inserted there, which was so arranged that it would make the electric contact which started the fan in the unit. If for any reason there was no steam, the fan would not start. If the steam supply failed, thermostat number two would cool off, and so stop the fan.

An arrangement similar to this was used also at the remote ends of vapor heating systems to prevent the gas or oil fire in the boiler, often affected too quickly by a centrally located house thermostat, from shutting the fire off before heat reached the remote radiators.

In the days when the light-weight tube and sheet radiation was new, we often were put to it to devise the desirable lag or time-element-delay in automatic temperature control, and the most hopeful solution seemed to be the adoption of inter-connected thermostatic elements somewhat like those for the Columbus unit heaters.

In this building we noted the ultra violet light meters and regulators, which were developed and used so satisfactorily following the classical studies of 1929-30 of the department of health of the city of Chicago. Little did we imagine, in the benighted days of that decade, what profound health influences would be discovered in the light effects beyond the power of the ordinary human eye to detect, and which are so potent in our modern health conditions!

I am impressed, on looking back over the engineering

literature of ten years ago, by the influence which the administration of Herbert Hoover had on engineering-civilization. In those days people were beginning to talk of air-mindedness, meaning an open-mindedness toward, or a prejudice in favor of, aviation.

Mr. Hoover, our first engineer-president since George Washington, awakened the nation to engineering-mindedness and brought about very rapid and progressive developments in engineering.

A large manufacturer had printed in his catalog not long before 1928, metric system measurements in parallel columns to the conventional measurements of that day. In this era of world-wide metric adoption, with its so greatly simplified labor of mathematics and transposition, it seems almost unbelievable that so great a controversy should have been waged for so long a time over the matter.

In 1928, people were still trying to express boiler capacities in "horsepowers" and also were speaking of prime mover potentials in "horsepowers."

In 1928 the input to radiators was expressed in heat units and the output was called square feet. This "square feet" had nothing whatever to do with the amount of heated surface or with the effective service given by the radiator.

The Brabbee-radiator efficiency meter had not yet been invented, and they were laughing at some of us who were groping for a term and a meaning which, like the Einstein theory, seemed beyond the ability of the ordinary mind to grasp.

Dr. Brabbee's meter solved this difficulty and, of course, today all radiator outputs are measured by it and are rated in heating comfort which the radiator delivers, rather than as they were formerly rated, in heat units put into the radiator.

In electric practice, the analogy was that an ampere might be called the equivalent of the heat input and a watt the useful output. In 1928 we had no equivalent to the watt and floundered around trying to make an ampere express a watt.

### The International Boiler Selection Scale

Nowadays, after computing the heat demand of a building, anyone may simply and easily select the boiler from the international scale.

This scale takes cognizance of the kind of use to which the building may be put, and which fundamentally reflects firing intervals and chimney heights. The output rating of the boiler under the testing code of the American Society of Heating and Ventilating Engineers, originally adopted in 1929 and revised many times since then, is absolutely dependable. The international scale gives the discount which should be taken from this rating for reasonable allowances in starting, indifferent attention, poor chimney or fuel, etc., and has a different discount each for bungalows, hotels, office buildings, etc.

The heat loss from each room is compared with the Brabbee meter scale for each kind of heating surface, and so we select the radiator.

The pipe sizes are of course no longer in "square feet," but are selected from tables based on their capacity to convey heat.

Considerable speculation used to be carried on because, while a valve with an orifice of a fraction of an inch would serve a given duty, the pipe-line connections to that valve would be several hundred per cent larger than the orifice.

The pipe sizes had to be so big because they continually would clog with debris if made small.

A great deal of the trouble has been proved to have been caused by the varying diameters, contracted veins and resistance at screwed fittings.

# Controlling Drinking Water Temperatures

A well regulated supply of circulating drinking water is a question of live interest to every industrial plant, institution and building as the season approaches when cool drinking water means so much to the comfort and efficiency of workers. Many methods of controlling the temperature of such water can be employed. The one illustrated here has proved satisfactory in several Rochester, N. Y., factories.

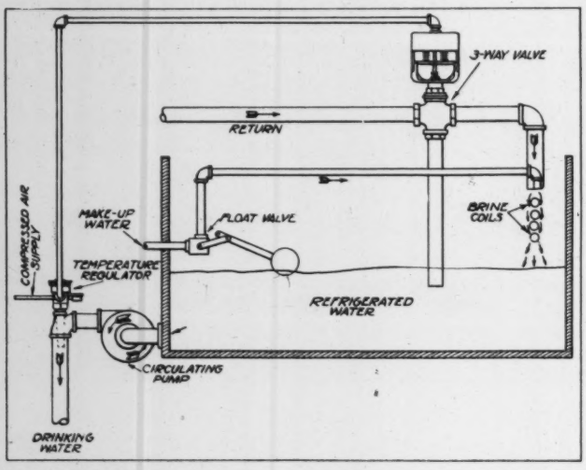



Fig. 1—Diagram Showing Application of Temperature Regulator and Three-way Valve on Cooling System for Drinking Water

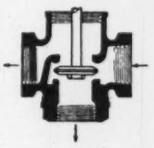


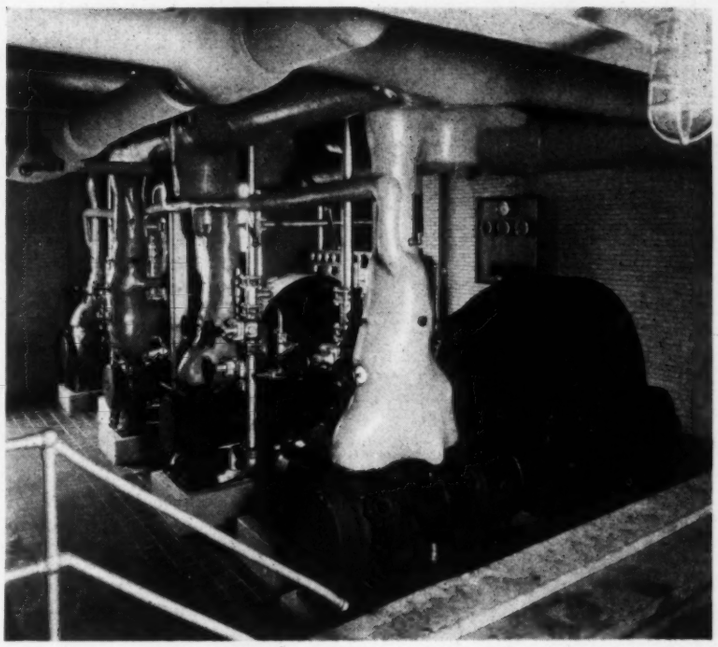
Fig. 2—Three-way Valve

The diagram, Fig. 1, shows a circulating pump taking a supply of refrigerated water from a tank. In the discharge line from the pump, or in the tank itself, is located a temperature regulator set at, say, 40 degrees. This regulator operates a three-way valve.

With the valve disc in one position, water from the return is passed out and over the brine coils, which cool it in its passage into the tank. When the temperature gets too low, the regulator changes the position of the valve disc and by-passes the water direct to the tank rather than over the coils. A drawing, Fig. 2, of the three-way valve is shown.

The valve connections are so arranged that if the air supply should fail, the water will pass to the tank direct, rather than over coils. This insures against a freeze-up.

Make-up water is added to the tank by a float valve.

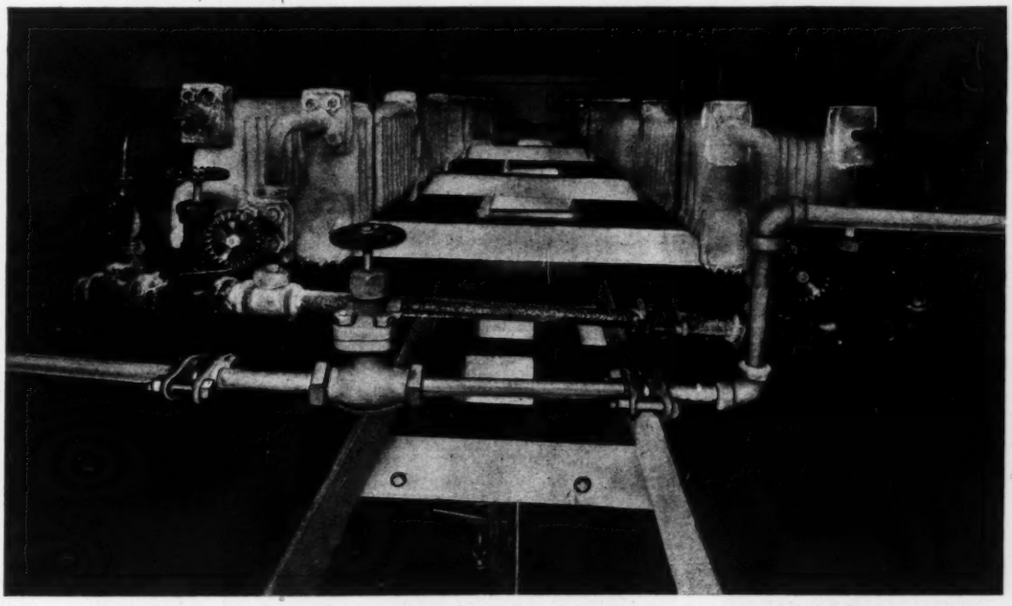


# Refrigeration

## *its development and its future*

*By* Lewis Lipman

THE INCESSANT effort of man to overcome the limitations of his environment is manifested in his effort to secure cool conditions in tropic surroundings. It is said that the early Chinese dynasties supplied the royal families with chilled delicacies thousands of years ago. It is also said that the Egyptians likewise favored their rulers. During the time of Alexander the Great in his campaign against the Persians, snow was used to chill his wines. We have rather complete descriptions of Nero's royal banquets, particularly the one on Lake Agrippa, to which the Numidian slaves carried the snows from the Alps in order that the food and wines served at that banquet might be properly chilled. Even subsequent so-called barbarians, during



A Large Commercial Installation. A Bunker Loft Cooling Room in Denver

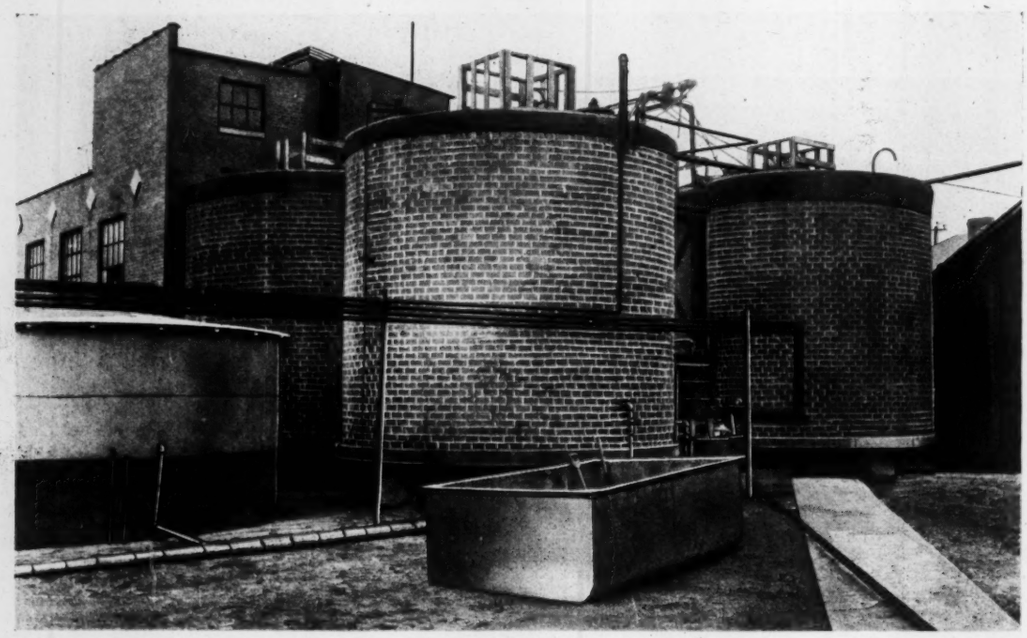
Charlemagne's reign, had begun to realize one fact, namely, that water-ice lasted longer than snow because of its increased density, and we are told of the storing of this ice in his and later reigns of the feudal period.

### Some Early Experiments in Refrigeration

It was about this time, namely, 1550, that the first efforts along scientific lines for the artificial development of cold were made. These first attempts were, of course, both crude and unprofitable, but they combine to lead up to the perfected apparatus used today. Almost the first attempt in this direction of which we have any record, is that of the Italian physician and scientist, Vlasius Villafranca, by name, who, in the year 1550, determined that a marked temperature reduction could be produced by dissolving saltpeter in water. In 1607 another Italian, Tancredus, produced still lower temperatures through the blending of snow with saltpeter. This may well be said to be the first discovery of the "frigerific mixture." A common example of the "frigerific mixture" in use today is the blending of ice and common or rock salt which was for many years the customary way of producing and preserving ice creams and the like.

Later on, experimenters discovered other "frigerific mixtures," many of them employing snow or ice as an auxiliary to the chemicals used, as did Tancredus. Others employed simple chemicals in combination, such as muriatic acid, nitrate of ammonia, sulphuric acid, calcium chloride, sodium chloride, etc. In conjunction with these, it is probably interesting to note in his article "Science Remaking Everyday Life," by Edward F. Slosson, the following: "The chronicle of a century of effort to approach the farthest north of temperatures, absolute zero, is as fascinating as the temporary struggle to reach the geographic pole, and, unlike the other, has proved profitable at every stage.

"When Fahrenheit, in 1724, stuck his mercury into a mixture of salt and snow, he thought he had reached the lowest possible point, and boldly scratched a zero on the glass tube, but it was not long before scientists began to climb down the minus steps."



Paraffin Coolers of Oil Company in Pennsylvania

### Refrigeration in the Last Seventy-five Years

There, then, were the first methods for producing artificially low temperatures. In order to carry beyond this point in the development of the art, it was necessary for several discoveries to be made and their consequent results practically applied, before the great strides made in refrigeration during the past seventy-five years could occur. These discoveries came in somewhat the following sequence:

About the time of the battle of Lexington, in 1775, an Englishman, Dr. William Cullen, devised a purely mechanical means for producing ice. Needless to say, it was nothing more than a gesture toward purely mechanical production of cold. This is also true of the first patented machine for this purpose, which patent was taken out in 1824 by one Monsieur Vallance of France. His apparatus consisted of shallow pans containing water, over which a current of dry rarefied air was circulated. The vapors arising from the water were absorbed by the air and, as the process of evaporation continued, the heat necessary to produce these vapors being constantly extracted from the main body of the water, lowered its temperature sufficiently to produce freezing. The aqueous vapors with which the air was laden, after passing over the water, were absorbed by causing the current to flow into a vessel containing concentrated sulphuric acid. By this means, the air was rendered fit for its process of again taking up new vapors from the water to be frozen.

With this method, the process of freezing was rendered continuous. A simple example of this process has been in use by desert travelers for many years. It has been the custom on desert travel, to carry vessels containing drinking water, which vessels are covered with a heavy cloth. By keeping this cloth saturated with water, the evaporation of this water necessitated the absorption of the heat contained in the water in the ves-

sel, and the temperature of the water thus contained, was very appreciably reduced.

Following this Vallance invention, we find that a Jacob Perkins in 1834, contrived an apparatus for producing artificial cold by the evaporation of ether, and it was in this process that the first compression system was inaugurated. The ether was allowed to flow into a cylindrical vessel containing tubes, where it was vaporized in consequence of the reduction of the pressure caused by the suction of a pump at one stroke of the piston; and was compressed into another vessel, cooled by water, at the return stroke. By this means the ether was restored to its liquid form and prepared for re-use.

It should be here stated that Dr. Faraday of London condensed ammonia gas into a liquid by the now common method of compressing the gas and then cooling it. The liquid thus condensed by this process, of course, boiled off rapidly into a gas again, absorbing heat in the operation. It was this development which made possible the vast majority of the present large ice and cold storage plants.

It might be well to elaborate a little here on the first important effort to manufacture artificial ice, for it should be noted that all efforts considered up to this point, were more or less of the laboratory or experimental nature and all efforts at practical temperature reduction were looked upon as a matter of remote development. This is indicated by Lord Bacon, in his "Sylva Sylvarum" wherein he comments as follows: "Heat and cold are Nature's two hands whereby she chiefly worketh, and heat we have in readiness in respect of the fire, but for cold, we must stay until it cometh, or seek it in deep caverns or high mountains, and when all is done we cannot obtain it in any great degree, for furnaces of fire are far hotter than a summer's sun, but vaults and hills are not much colder than winter's frost." There can be no doubt of Bacon's realization of the value of such control of cold as of heat, yet there seemed to be no vision of its possible consummation.

Ice, of course, was in quite prevalent use from the time of the Revolutionary War, for we have records indicating the sale of it in the streets of England and in home deliveries in America about 1800. Still further shipments of natural ice were begun from America about this same time. The records indicate the shipment of a shipload of ice by one Frederick Tudor of Boston in 1805, the ice being sent to Martinique in the West Indies, for the purpose of assuaging the sufferings from an epidemic of yellow fever raging there at that time.

**Twining, the Father of Compression Refrigeration**

The year 1850 saw two very important events in the field of artificial ice-making. In their proper order, let us first consider that of Professor Twining of New Haven, Conn., who developed an ice making compression equipment using ether as the refrigerant. This scientist, of quite original and advanced thought, had been experimenting for some time with sulphuric ether, with the view of devising some tangible process where ice could be produced in remunerative quantities. His first patent was obtained in England. Another was issued to him in the United States in 1853, and a machine was placed in operation in Cleveland, Ohio, two years later. Among the discoveries developed during his early experiments, Professor Twining had determined that by the evaporation or vaporization of 1 lb. of ether, 1.2 lb. of water-ice could be produced from water at a temperature of 32 degrees F. He also proved that the temperature of ether could be reduced 28 degrees. It was upon this and other data obtained that the system employed in his Cleveland machine was developed.

In this apparatus, he used a double acting vacuum and compression pump, having a diameter of 8½ inches and a stroke of 18 inches, moving at a speed of 180 strokes per minute. A tubular "restorer" or condenser was used in which the ether was retained in liquid form, by reason of the pressure induced by the compressing action of the pump, combined with the cooling effect of water at a relatively lower temperature. The liquid ether was permitted to flow through a pipe and valve which regulated the flow, to a part of the apparatus called the "cistern" in which, on account of the re-

SMALL COMMERCIAL INSTALLATION IN MINNEAPOLIS

A Domestic Refrigerating Unit in Display Freezer Case

duced pressure existing therein owing to the sucking action of the pump, the ether would pass into its gaseous state, and so extract heat from the surrounding surface of the "cistern."

This "cistern" was made in such a manner that it comprised a number of cells open at their tops and containing a liquid non-freezable except at extremely low temperatures. In this non-freezable liquid were immersed iron moulds, also open at their tops, and filled with the water to be frozen. After this water had been completely changed to ice, these moulds were lifted from their cells and subjected to a bath of tepid water, as is done today in order to facilitate the removal of the ice block.

Professor Twining also discovered that by freezing water at a comparatively high temperature the resulting ice would possess the much desired quality of transparency, except for a small porous core in the center of the block; whereas, if the temperature was unduly low, the product obtained would be opaque.

This Cleveland machine was designed to produce 1 ton or two thousands pounds of ice in twenty-four hours. The highest actual production attained, however, was about sixteen hundred pounds, and this under certain disadvantages. This equipment could not be set up and made a success commercially, for the production of ice was out of all proportion to the current price of natural ice obtainable in Cleveland from Lake Erie and surrounding small lakes. It was, however, operated occasionally during the interval from 1855 to 1857.

An interesting fact with regard to this equipment is that the process employed, with the exception of the refrigerating agent used, is identical with the compression system of the present day. To Professor Twining, therefore, should solely belong the credit of having developed the cycle of compression refrigeration in its application to the manufacture of ice.

### When Air Was Used as a Refrigerant

It was also in the year 1850 that Dr. John Gorrie of Apalachicola, Fla., first devised an air compression equipment for refrigeration purposes. He obtained a patent on this equipment in 1851. Briefly, Dr. Gorrie's machine might be described as follows: In prior tests, Dr. Gorrie had established a method for generating cold through the known principle that the compression of air increases its temperature, while its expansion decreases its temperature. He now developed a compression of the air up to four or five atmospheres or from sixty to seventy-five pounds, thereby advancing the temperature of the air many degrees. He conjectured that by permitting this compressed air to expand after it had assumed the temperature of the surrounding atmosphere (resulting from the cooling effect of water), its decrease in temperature below the normal must be in an inverse ratio to its original increase in temperature. Thus, it was proved by Dr. Gorrie that artificial cold could be generated with nothing but the atmosphere as a refrigerant, and that chemicals could thus be dispensed with entirely.

This, of course, offered great inducement to inventors everywhere and for many years research along these lines was continued. It should, of course, be remembered that the laws relating to thermodynamics had not been clearly defined, at that time. These laws have since deprived Dr. Gorrie's efforts of considerable value from a scientific standpoint, for it has since been proved that heat and mechanical duty are the equivalent, one of the other, and that the mechanical energy necessary to compress a given quantity of air so greatly exceeded the work necessary when a volatile liquid such as anhydrous ammonia was used, that efforts began to be directed along these latter channels.

### The Ever Broadening Field of Refrigeration

It will be noted that no apparent effort had yet been given to the production of artificial refrigeration for any purpose other than of ice-making. The comparatively limited sense of things at that time had prevented a proper grasp of the almost unlimited application of artificial refrigeration which is still being developed. With the gradual unfoldment of this idea, and its practical applications to current progress and developed necessities, refrigeration has just naturally divided itself into three distinct general groups, viz:—

(1) Large Commercial
(2) Small Commercial
(3) Household units, etc.

The large commercial field was the first to develop, for two distinct reasons, namely (a) larger savings and (b) greater needs. This larger commercial field, or group, covers all plants of nominal twenty tons capacity per day and over, necessitating the continuous services of licensed operating engineers. This group started, as before stated, with the ice-making plants. Following this came the cold storage plant, or warehouse; then the dairies and ice cream factories, including the assembly plants, where the milk is brought together for shipment to the dairies and where the animal and other sensible heat was removed to a degree.

*Future articles in "Heating, Piping and Air Conditioning" will attack in a specific manner the many problems that arise from day to day in this young yet giant industry—refrigeration.*

*The Editor.*

# Air Conditioning

*"In the factory of a prominent silk manufacturer, during a temporary shutdown of air conditioning equipment, production was reduced 27 per cent."*

*"A cigarette manufacturer increased the output of his automatic machines four-fold."*

*"Theaters . . . . the largest department stores . . . . have found air conditioning essential."*

*"Air conditioning and cooling for summer may become a necessity."*

*"Office skyscrapers of the future may find it preferable to dispense with windows."*

*In this wise does Mr. Carrier find proof that air conditioning is on the verge of a vast expansion in its applications to the manufacturing processes and in its benefits to human comfort and health*

# New Prospects *for an* Established Industry

*By* Willis H. Carrier

TWENTY-FIVE years ago "air conditioning" was an unknown quantity, either in theory or practice. Now it is a well established industry.

Today, air conditioning is recognized as a scientific method by which it is possible to control manufacturing conditions in certain industries, so that the products do not vary in quality from day to day and from season to season. Not only is quality maintained, but the production is not interrupted due to unfavorable weather conditions. Thus the cost of production is decreased.

Air conditioning undoubtedly is effecting an economic gain in various industries throughout this country of millions of dollars annually. In some industries, air conditioning equipment has been known to pay for itself in the first month of operation, while in others, calculable savings are found to pay for the equipment in the first three or four years.

The intangible advantages may be even of greater value. On the estimated amount of air conditioning equipment in use, and the average return to the user which it produces, it is probable that the present economic saving in the United States alone is nearly $15,000,000 annually.

Any normally healthy industry, especially if it be a relatively new industry, will show each year a geometric progression in its curve of increase. The curve of the air conditioning industry is one which shows a doubling in volume about every five years. This, of course, is much more rapid than the geometric curve of the growth in population of the country. While this may be explained in part by the increasing per capita purchasing power of the individual, the principal reason lies in the fact that air conditioning has decreased greatly the labor as well as the capital required per unit of production in

such industries. Thus, air conditioning, by lessening the cost of production, has not only increased the profits of the manufacturer, but it has ultimately increased the purchasing capacity of the individual.

### A Contributing Factor to Prosperity

Air conditioning may thus be classed with industrial electrification, automatic labor saving machinery, and increased transportation facilities, as one element contributing to the present day prosperity of the people of these United States.

Perhaps the most striking way of visualizing the economic contributions of air conditioning to the country's wealth and prosperity is to state, as we may be permitted to do on the foregoing basis, that it actually increases the average purchasing capacity of every man, woman and child in the United States twelve cents a year. Furthermore, taking into account the relative growth of air conditioning with respect to population and amortization of equipment, we may expect that the effect of this art upon the purchasing capacity of the American people will double every six years for some time to come. That is, in eighteen years from the present time, air conditioning may be expected to put into the pocketbook of each and every person in the United States annually one additional dollar.

From the standpoint of possible industrial economy, air conditioning is in its infancy. Air conditioning in conjunction with improved equipment has made it possible for one cigarette manufacturer to increase the output of his automatic machines four fold. During a temporary shutdown of air conditioning equipment in the factory of a prominent silk manufacturer, the lack of air conditioning reduced production 27 per cent. Never before had this manufacturer appreciated the significance of this new science.

The researches of the American Society of Heating and Ventilating Engineers at its laboratory in Pittsburgh, have studied the effects of temperature, humidity and air motion in relation to human comfort so that such applications are now placed on the basis of an exact science, and the effects which may be expected from air conditioning equipment are readily determined. This may be said to be one of the outstanding achievements of the research work of this society and it is becoming recognized in scientific circles throughout the world.

### Will Become a Necessity

In the past we have given attention to the heating of our dwellings, offices and factories for the purpose of human comfort. In what now seems to us the "dark ages," this was considered a luxury rather than a necessity, as today. Similarly, in years to come, air conditioning and cooling for summer may become a necessity rather than a luxury, and we will look upon present times as marking the end of that "dark age" in which there was but relatively little cooling for human comfort.

The office skyscrapers of the future may find it preferable to dispense with windows and the street noises and dust which they admit, and avoid the great wastes in congested cities due to unoccupied courts and areaways now used for purposes of window ventilation and light. Sun-ray electric lighting may prove equally good and much more dependable than sunlight itself. Ventilation both in summer and winter can be made much better than outside conditions which at present permit either excessive dryness or an intolerable humidity within enclosures.

### Use of Refrigeration Growing

The use of refrigeration in connection with air conditioning is growing apace. Motion picture theaters have found that air conditioning with refrigeration not only gives comfort to the patrons in summer, but, instead of showing an operative loss, has made the summer months the most profitable part of the year. People flock in to become cool and be comfortable as well as to see the show. At present, only a very small percentage of the total theaters are thus equipped. Eventually all theaters having a capacity of over a thousand seats will, of necessity, be equipped with air conditioning and refrigeration.

The larger department stores have found air conditioning essential to an effective campaign for summer sales. In fact, it is a producer of sales the year around. The Hudson stores of Detroit, Mich., were pioneers in this field. The installation in their basement required a capacity of six hundred tons of refrigeration, or the equivalent of fifty truck loads of ice in ten hours of operation during the hottest summer day. Their new building, which is now just being completed, will require practically twice this amount. Banks and offices are finding that air conditioning, with refrigeration for summer, is desirable. It is presumed that many other industries will eventually find such applications to their advantage.

### Press Button—Heat or Cool Your Home

The use of refrigeration for maintaining comfortable living conditions in the home during extremes of summer heat will be a development of the very near future. It will be an improvement which can be applied to the home of the average man as well as to that of the wealthy. The application of thermal equipment for comfort in the home is of more importance than for office buildings or theaters, yet it has received far less engineering attention.

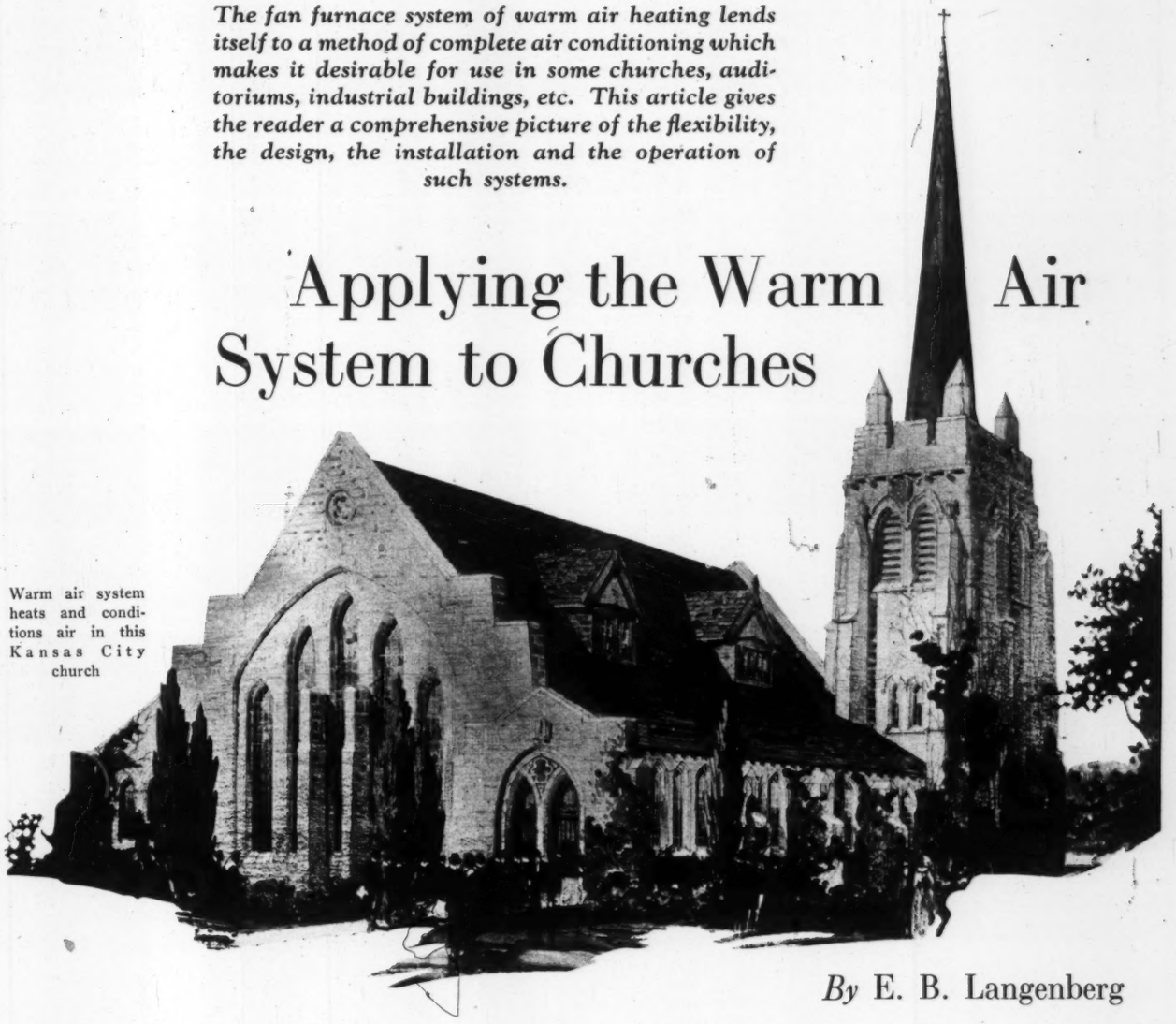
The home of the future will, in my opinion, be heated largely by air warmed directly by a gas or an oil-fired furnace, the warm air being distributed by noiseless, low-pressure fans. Such furnaces can now be built of rust-proof, light-weight steel at a relatively low cost, and will operate with an efficiency of approximately 90 per cent under all conditions. With this type of heating it is a relatively simple matter to attach air cooling by refrigeration, permitting the entire equipment to be located centrally in the basement.

Gas affords a suitable means for the production of such refrigeration. Some safe and simple absorption system may be developed, or an ejector type of system, using water as a refrigerant, may be the ultimate design; but, in any case, I venture to predict that it will soon be possible to press a button and place your house-heating system in operation under automatic control or to press another button to start your house-cooling system, as required.

This will bring the benefits and comforts of the mountains or seashore to our homes in summer, as well as the climate of Florida and other warm localities to our dwellings in winter.

*The fan furnace system of warm air heating lends itself to a method of complete air conditioning which makes it desirable for use in some churches, auditoriums, industrial buildings, etc. This article gives the reader a comprehensive picture of the flexibility, the design, the installation and the operation of such systems.*

# Applying the Warm Air System to Churches



Warm air system heats and conditions air in this Kansas City church

*By* E. B. Langenberg

HEATING of audience rooms offers to the heating engineer a diversity of problems that are seldom met in other types of buildings. In no two churches, for instance, does the contractor or engineer encounter the same kind of difficulties. In each installation there is a rearrangement of conditions which call for the best theory and experience of the heating engineer.

Too often, carelessness in design as well as the desire to meet competition in price creates a bad situation, causing the engineer's reputation to be lowered in the opinions of the 200 to 1,000 or more people who occupy these rooms at regular intervals.

Pet theories are dangerous things to play with in heating a large church auditorium with adjacent Sunday school rooms. One must know what is required, and after a thorough study of the problem, he should design the plant to heat and ventilate in the most economical way.

There are types of churches in which it would not be advisable to install a hot water system. There are others in which a steam system or a warm air heating system might not be suitable. The engineer who studies the problem and meets each condition as it arises, can determine very easily the suitability of each type of system and so provide a heating plant that is economical in first cost, in maintenance and in operation, and which will meet the particular requirements of the church in which it is installed.

### Conditions Which Must Be Met

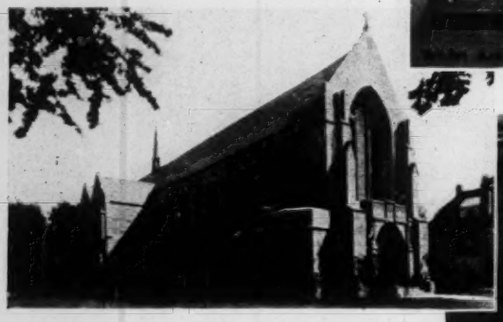
In the first place, heat losses must be computed accurately. Consideration must be given to outside vestibules, and the opening and closing of connecting rooms, either isolating them or making them a part of the auditorium.

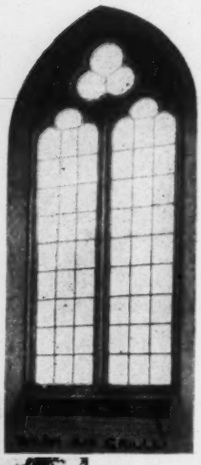
A fundamental requirement is that churches be heated quickly and that there be a reserve capacity for extremely low temperatures and wind pressures.

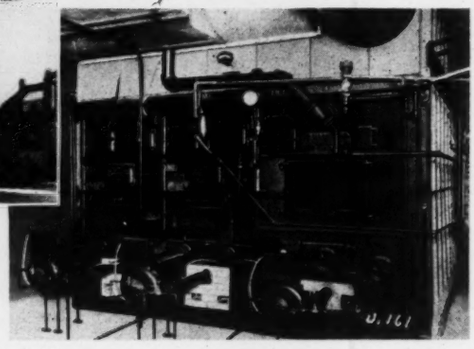
Another factor that must not be overlooked is the effect of the congregation on temperatures after having assembled. This frequently requires that the heating part of the system be slowed down at least 30 minutes in advance of the audience assembling.

Plants are sometimes required to heat only one part of the building and at other times the entire building, and it has been found advisable in such

cases to install systems that have a capacity sufficient to heat the entire building and to install the controls in such form that parts of the building may be heated economically and efficiently under varying weather conditions. This in itself requires that heat losses must be figured on walls which may be cold on the other side, and the capacities for the room being heated must be great enough to overcome the heat losses and still maintain the proper temperature.







Warm Air Heating Plant in an Ohio Church

In laying out heating plants for churches, the engineer frequently will find himself confronted with problems of determining under what conditions balconies become overheated and what types of systems tend to such overheating. It is obvious that when power is applied to force the air there is more likelihood of providing equal distribution of heat in parts of the building that are normally difficult to heat. If hot water heating is considered, the engineer will consider the likelihood of the church being left without attention during periods of extreme cold. He will also consider the time required to bring the church to the required temperature by this method. This is best determined by the size of the church and the conditions under which the plant is to be operated.

### How Warm Air Meets the Problem

Furnace or warm air heating is in common use for this type of work. Large volumes of air are handled, conditioned and kept in motion, thus combining heating and distribution within one piece of apparatus. The warm air furnace is adapted to almost any type of fuel and, having a capacity limited only by the rate of combustion of which the plant is capable, it has a flexibility that makes it very useful within the broad limits in which it can be operated. Such systems, equipped with fans, air washers, ozonators and a definite amount of humidity and under automatic control, are used in installations where the most exacting conditions are encountered and where stratification of air should be eliminated.

Sometimes it is necessary to place two or more furnaces in a battery to provide capacity for the building, but considerable economy results from this, as all units do not have to be fired during the fall and spring months, or when only part of the building is in use. The response in temperature at the register is practically instantaneous as soon as the fire is under way. These columns of warm air, whether introduced at the floor or at the side above head or from overhead, create an air motion that is extremely desirable, serving a definite purpose in passing over the body and in diffusing odors and gases given off by the lungs and bodies of the people assembled. It is advisable that a certain amount of air be introduced into the system from outdoors, although most warm air systems recirculate the entire volume of air within the building a definite number of times during an hour. But even though infiltration and outfiltration take place, it is advisable to supply at least a 10% volume of new air for every turn-over in volume within.

By using a fan it is possible to handle a greater volume of air and to handle it much more rapidly than in a gravity system. The type of fan, however, has as much to do with the success of the plant as any other factor. It is extremely necessary that all resistances be calculated carefully and that volumes and velocities be balanced so as to get the greatest diffusion of heated air throughout the entire building. The squirrel cage type fan is used to a great extent in this type of heating, as it is desired to maintain a constant pressure throughout the system. It is also desirable to handle large volumes of air at low velocities, lessen the noise to the minimum and, of course, use as little power as possible.

In handling practically 90% recirculated air, it is possible to use the same principles that apply in school house heating and ventilating systems, in which the air is conditioned. Overheating should be avoided. The drowsiness produced by overheating is more noticeable, and consequently is objected to in audience rooms more than in some other types of rooms.

Care must always be taken that a column of warm air does not arise directly in front of the speaker's platform, as this has a tendency to deflect the voice and even deaden its carrying qualities.

Great strides have been made in the design of warm air furnaces for the maintenance of humidity, and it is now possible to maintain positive humidity.

The interior of the building should be divided into sections and each section should be controlled by a thermostat which actuates the damper in the conductor pipe leading to that section. As square pipe is mostly used, easy moving volume dampers may be installed and controlled electrically. Future developments along this line will undoubtedly lead to a master control panel near the furnace or furnaces where an operator can determine conditions in any part of the building as recorded by means of thermocouples. The heat can then be regulated from this central control.

Almost any kind of fuel may be used, but it would be advisable to secure a heater designed for the particular

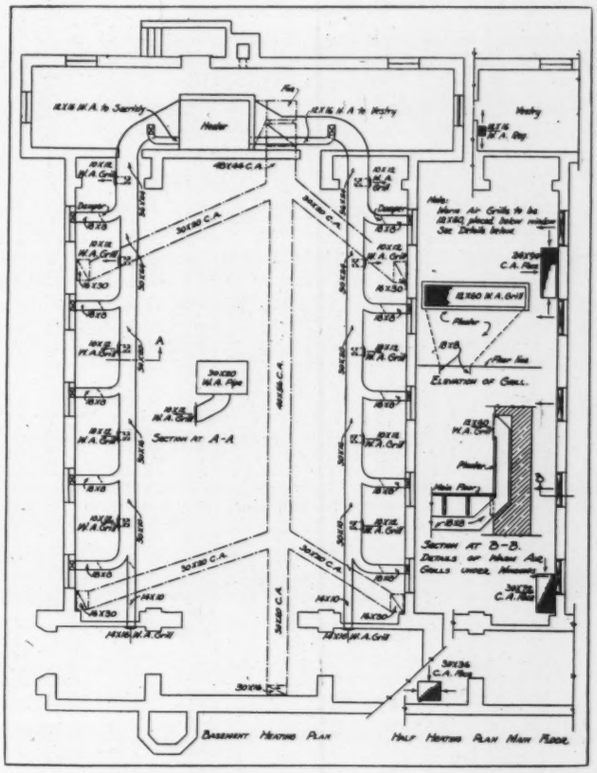
kind of fuel that the owner plans to use. Oil and gas, for instance, those comparatively new fuels, the use of which is increasing in many parts of the country, are being applied to a great extent to the warm air furnace.

Last, but not least, attendants of the heating system must be instructed carefully on the operation of the system and even printed instructions would be advisable. These should be placed near the apparatus and should be brought directly to the attention of new operators. Many such heating systems have failed to give satisfaction because of the neglect to provide instructions. The heating engineer who designs, or the contractor who installs, can not afford to overlook this important item.

### Flues Should Be Correct

The construction of the flue or flues should be specified by the engineer and too much attention or insistence upon correct construction need not be apologized for to anyone. The flue should be carried to a point well above the ridge of the roof and, on account of intermittent firing, it would be well to construct it within the building rather than on the outer side of an outside wall with three sides exposed. A square flue frequently has to be topped with about 6 feet of round steel pipe, as this practically prevents down currents in an especially large square flue.

The heating of churches and audience rooms calls for the best in the heating engineer and offers an opportunity for developing a high type of heating and ventilating system.




Plan of Warm Air System in a Church Similar to the One Pictured

# Use of Spacer Saves Waiting Time

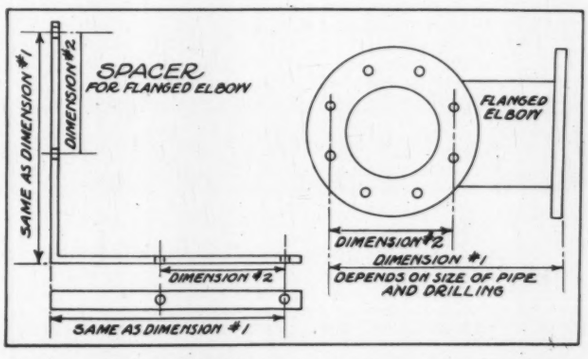
It is not unusual to have pipe work interrupted in a plant because of difficulty in getting certain fittings that was not foreseen when the work was started.

A case is recalled where a 14-inch low pressure steam line was being installed. Pipe and valves were on hand at the time the work was started, but three 14-inch long radius pattern, flanged elbows could not be furnished promptly.

The use of a "spacer," however, or as the pipefitters term it, a "skeleton elbow" (see accompanying sketch) made it possible for the work to proceed. It held each 90 degree turn securely and accurately in place and when the elbows were received it was a short and simple matter to remove the spacers and put the elbows in position.

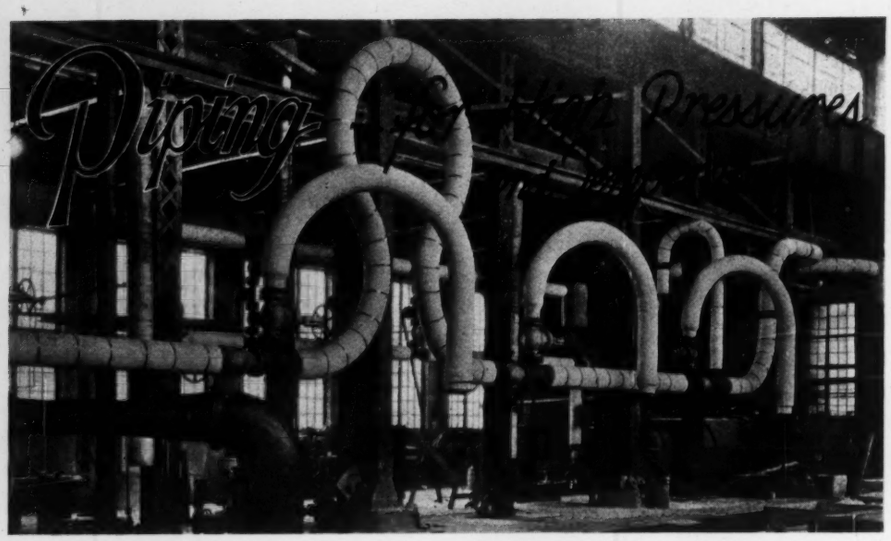
Careful attention must be given the drilling of the spacer so that when bolted in position it will hold the flanged pipe ends apart at a 90 degree angle and have them conform to the center to face dimensions of the elbow and the centers of the pipe lines.

Another similar case is recalled during the installation of some high pressure piping. A 6x3x4 flanged hydraulic steel tee was needed as the starting point for the pipe work. The best promise of delivery from several manufacturers was four weeks. A workman handy with an oxy-acetylene torch made up from two pieces of standard pipe and three pieces of plate steel a spacer fitting true to the dimension of the proper fitting. Careful consideration was given to male and female contact faces. This spacer was used as the starting point and by the time the hydraulic press, accumulator and pump were connected up, the proper fitting was received and promptly put in place.—W. H. W.




Showing How a Spacer for a Flanged Elbow Can Be Used in Saving Time in an Industrial Plant

# Piping for High Pressures



Pressures of over 400-lb. and temperatures up to 750 degrees are provided for in this piping system; 9 inches of expansion had to be taken up

*By* Prof. A. G. Christie

THE TREND of steam power plant development, in both central stations and industrial plants in this country, is definitely toward higher pressures and temperatures. Economic gains may be secured through their use under certain operating conditions which are of sufficient value to make the new conditions attractive. But new problems have developed with higher pressures and temperatures and some of these, particularly certain piping problems, are still only partially solved.

The limit of economical steam pressure a few years ago was about 400-lb., the highest pressure at which riveted drums of large size could then be built. Several western plants were next built for 550- and 600-lb. steam pressure. I. E. Moultrop was bold enough to try 1,400-lb. in Edgar Station, Boston, and, after the satisfactory operation of this plant, others of 1,200- to 1,500-lb. have been built.

### Cost of High Pressure Plants

The first plants at each pressure were development jobs and their first costs were probably more than those of standard plants of lower pressure. Greater familiarity with the construction of high pressure plants and a better appreciation of their operating characteristics, however, have led to a modified viewpoint on cost. In a recent address, Mr. Moultrop stated that the 1,200-lb. plant should cost no more per kilowatt of capacity than a standard 400-lb. plant; the increased cost of those parts subject to high pressure is a small proportion of total plant cost and is offset by lower cost of condensers, intake water tunnels, fans, etc., due to the lower steam consumption. Many engineers do not agree with Mr. Moultrop on the relative costs of high and standard pressure plants. For instance, H. B. Brydon, in his paper on "Some Economic Factors in Power Station Design," American Society of Mechanical Engineers, 1928, showed that a 1,200-lb. plant cost about 40 per cent more than a 400-lb. plant. There are, thus, differences of opinion regarding the design and cost of high pressure plants among engineers. As long as American engineers limit themselves to total temperatures around 750 degrees F., steam should be reheated at some point in its expansion when pressures above 500-lb. are used. Otherwise, it becomes so wet in the low pressure sections of the turbine that blading erodes rapidly and its efficiency is decreased.

### Reheating

Reheating may be carried out on single-cylinder units by withdrawing the steam at some intermediate stage, carrying it to and from a reheater, and returning it at the next stage. Many engineers do not favor this construction and prefer either two-cylinder machines or a high and a low pressure unit, each with its own generator. These two-cylinder sets are more expensive than single-cylinder machines and require greater floor space.

Reheating is generally handled by returning the steam to one or more boilers which are equipped with reheating superheaters. This construction involves additional piping carrying a moderate steam pressure, and introduces certain operating complications. If load is suddenly dropped, for instance, a considerable volume of steam will be trapped in the piping and the reheater which, if allowed to pass to the low pressure turbine, may cause overspeeding. Reheater boilers must be of special construction and also require more care in operation than standard boilers.

Reheating is done by high pressure steam on one of the units at Crawford avenue, Chicago, where an initial steam pressure of 550-lb. is carried. Such steam reheating does not produce as high an operating efficiency as reheating by furnace gases when 1,200-lb. pressure is used. The new Holland station of the General Gas &

Electric Co., with 1,400-lb. boiler pressure, will use a steam reheater and a flue gas reheater in tandem.

The advantages of higher steam temperatures have long been recognized. For instance, if a steam temperature of 1,000 degrees F. were possible with 1,200-lb. pressure, reheating would scarcely be necessary.

Such a temperature is beyond the point at which many engineers believe ordinary steel is safe under pressure. The trouble arises from the phenomenon of "creep" in metals. When stressed at temperatures above 800 degrees F., steel tends to flow or stretch. Research, though, has indicated that certain chrome and chrome-nickel steels do not creep appreciably under moderate loading up to 1,000 degrees F. This has raised the hope that steam temperatures may soon be increased above the present limit of 750 degrees F. In Europe, temperatures of 840 degrees F. are in use. The new Loeffler, and Brown-Boveri, boilers propose to use steam temperatures of about 1,000 degrees F. Much useful data on metals for high temperatures will be found in papers by Prof. A. E. White and V. S. Malcolm in A. S. M. E., N. E. L. A., and other proceedings.

Consideration must also be given to fatigue and corrosion fatigue of metals at high temperature. The various publications of Dr. D. J. McAdam Jr. before the American Society for Testing Materials and the A. S. M. E. give data on these phenomena.

Table I, taken from H. L. Guy's paper on "Tendencies in Steam Turbine Development," in *Engineering*, London, Feb. 1 and 8, 1929, indicates the per cent gain in thermal efficiency for various temperature increases.

**Table I**

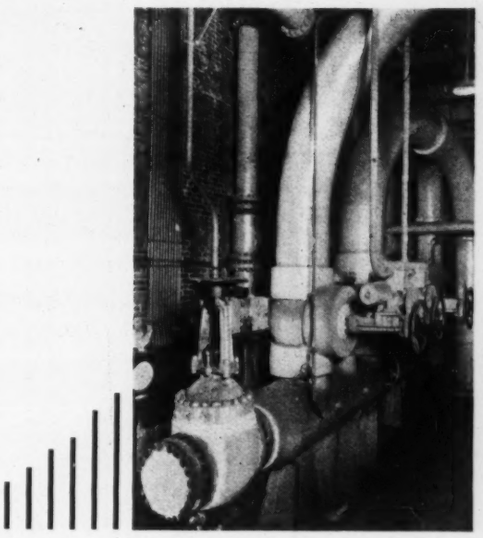
INCREASE IN TOTAL TEMPERATURE FOR 3 PER CENT STEPS IN THERMAL EFFICIENCY.

Basis.—700 degrees F. total temperature. 29-inch vacuum, 4-stage feedheating including boiler and condenser auxiliaries.

| | —Per Cent— | | | |
|---|---|---|---|---|
| Increase in thermal efficiency | 3 | 6 | 9 | 12 |
| Initial Pressure lb. per sq. in. G. | Increase in Temperature Degrees F. | | | |
| 200 | 77 | 151 | 227 | 302 |
| 250 | 77 | 155 | 232 | 309 |
| 350 | 79 | 158 | 237 | ... |
| 500 | 79 | 159 | ... | ... |
| 750 | 77 | ... | ... | ... |
| 1,400 | 65 | ... | ... | ... |
| Reduction in coal consumption, per cent | 2.92 | 5.66 | 8.26 | 10.71 |

## High Pressures in Industrial Plants

The use of high steam pressure in industrial plants is largely determined by the possible demand for steam at moderate and low pressures for process work, and by the plant's electrical requirements. Where the latter are large and considerable process steam is needed, then the heat drop resulting from the use of high pressure steam expanded through a turbine to the process pressures will supply some of the electrical requirements at a heat cost of approximately 4,500 B.t.u. per kw-hr. The fixed charges against this power will only be the excess cost of the high pressure boiler, superheater and piping over similar equipment for process pressure, together with the cost of the reducing turbo-generator. The net savings resulting from such installations are often so large that one will hear of increasing numbers of such plants as engineers become more familiar with the use of high pressure equipment.



These lines carry superheated steam at 320-lb. pressure with a total temperature of 700 degrees and are insulated with 1½-inch high temperature insulation

As far as construction and operation are concerned, high pressures have presented no really serious difficulties either in boilers or turbines. Contrary to the general impression among engineers, turbines properly designed for a large flow of steam at high pressure and superheat, and exhausting at comparatively high back pressure, may operate at excellent economy. Last year's report on "Higher Pressures and Temperatures" of the prime movers committee, N. E. L. A., gave the engine efficiencies of two such turbines as 78 per cent and of the third as 80 per cent.

Many industrial plants using high pressures should also include steam storage as part of their equipment. Steam accumulators may effect large savings by supplying the peak demands of the process and may also speed up production, thereby permitting an increased output of salable plant product and, hence, increased profits. At the same time, the operation of the high pressure boiler and turbine would be more constant and efficient, for the accumulator would take up the fluctuations in steam supply and demand. The advantages of steam storage have been recognized in European factories, but American industrialists have not yet availed themselves to the fullest extent of the possible gains by this means.

## Economy of High Pressures

Plants using steam pressures above 600 lb. have been planned with the expectation that they will operate at high capacity factors as base load plants. Some of these stations may be given such load throughout their useful life. Mr. Brydon, in the paper referred to above, seriously questions, in view of past experience, whether such high capacity factors would be obtainable, and undoubtedly he is in a large measure correct. The writer, though, can not think that power plant development has now reached a stalemate and believes that there will be as much development in the near future as in the recent past in generating power at still lower fuel consumption.

It is difficult to make specific comparisons of the per-

formance of plants at various pressures, for different conditions must be assumed for each pressure. The latest data are contained in the paper by H. L. Guy, referred to above. Table II is taken from this paper and presents some interesting and useful figures.

### Economic Limits of High Pressures and Temperatures

Many calculations have been published to indicate the economic limits of high pressures and temperatures. Mellanby and Kerr, in a paper on "The Use and Economy of High Pressure Steam Plants," I. M. E., 1927, proposed the following limiting cycle for such plant operation:—1,250 lb. per square inch steam pressure; 900 degrees F. initial temperature; reheating in two stages at 500 lb. and 180 lb. per square inch; eight bleeder heaters; 90 per cent boiler plant efficiency; and 29 inches vacuum. This plant would operate on 9,400 B.t.u. per kw-hr.—an astonishingly low figure, but one which suggests the further possibilities in steam plant development.

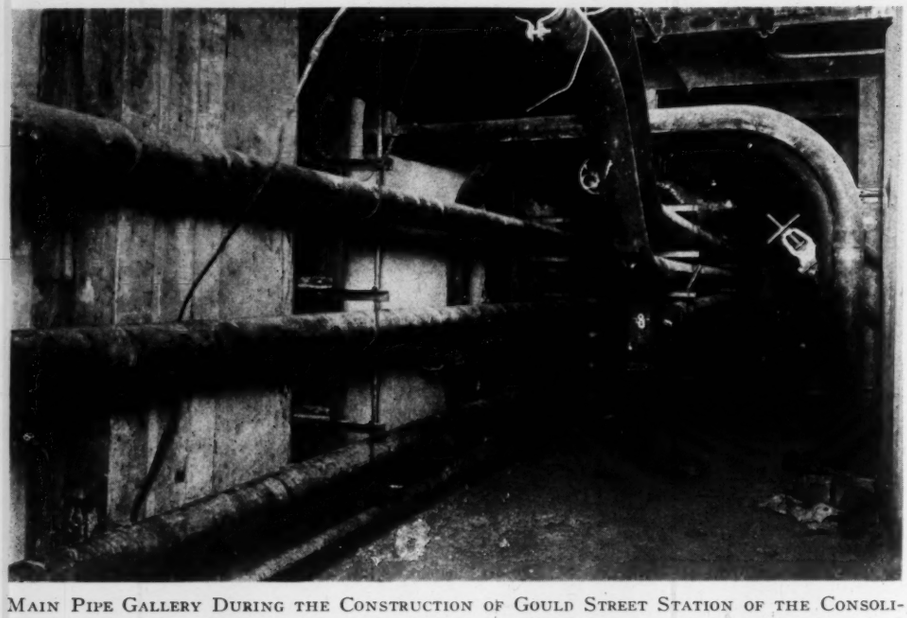
### Piping for High Pressures

In high pressure piping, seamless tubing is generally used with welded joints. Fittings and valve bodies of cast or forged steel are employed with increasing weight at high pressures. Cast steel parts must be carefully inspected for pin holes. The hot water test is useful for this purpose. In some cases, all cast steel parts have been examined by x-rays before use. This has proved to be a satisfactory though expensive inspection. Care must be taken in the design of valve bodies that there are no flat surfaces to deform under high pressures and temperatures. Alloy steels or monel metal are generally employed for seats and discs. Valve stems have been plated by chromium or nickel to prevent corrosion. In some cases steel castings have developed pin holes after use with high pressures and temperatures. While these are troublesome, they can generally be spot welded without much difficulty. Improved methods in steel foundries should eliminate this difficulty.

### Piping Design

High steam temperatures introduce problems in piping materials as noted above. Temperatures above 850 degrees F. may involve changes not only in the material of piping—alloy steels may be used in spite of their high cost—but in the arrangement of plant to lessen the amount of piping, to shorten runs, and to provide adequately for expansion. Possibly pipe welded throughout may eventually be adopted, and flanges and fittings completely eliminated. With very high temperatures an allowance must be made for some permanent deformation as a result of creep in valve parts and on straight runs of piping.

Bolts in flanges with steam over 850 degrees F. temperature are subjected to severe operating conditions. They must be highly stressed to hold the joint tight. If ordinary steel bolts are used, creep will occur at these temperatures and the resulting extension of the bolts may allow the joint to open. Special alloy steels of high strength are now used for such bolts. These are carefully cut from bar stock with threads at both ends and must be carefully tightened up in place. Much useful data on piping used in modern stations will be found in the 1925-26 report on station piping of the prime movers committee, N. E. L. A. This publication also describes and gives data on the 1,200-lb. piping at Edgar Station, Boston.



Main Pipe Gallery During the Construction of Gould Street Station of the Consolidated Gas, Electric Light & Power Co., Baltimore, Md., Showing Compact Arrangement of High Pressure Pipes Which Are Welded Throughout Without Flanges

The thickness of piping for high pressures may be found by the following formulas:

For pipe sizes ½-in. to 5-in.—

$$P = \frac{2\ S\ (t - 0.065)}{D} - 125$$

For 6-in. pipe and larger—

$$P = \frac{2\ S\ (t - 0.100)}{D}$$

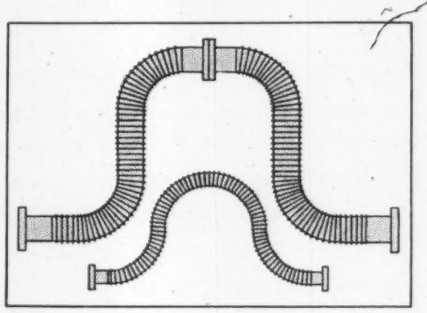
Where P=allowable working steam pressure above atmosphere, lb. per square inch; t=wall thickness, inch;

D=outside diameter of pipe, inch; S=working stress, (at 750 degrees F. S=9,000 for seamless drawn tubing and 7,000 for lap-welded steel pipe). Above 750 degrees F., lower working stresses must be allowed on account of the decrease in ultimate strength, the tendency to creep and the lessening of the fatigue limit. More complete data on the properties of piping materials at high temperatures are needed.

Practically no condensation occurs in piping when operating under high pressures and temperatures. Hence, drainage systems need only care for starting-up, banked conditions and stand-by plants. A satisfactory drainage system is one in which drips are carried to a receiver with a float operated whistle. The plant operators blow down this receiver periodically by hand into a feed water heater when both heat and condensate can be recovered. These drips at high pressure contain about 400 B.t.u. per lb., which should be saved.

Standardization committees are at work on the dimensions of flanges, fittings, etc., for high pressures and some tentative standards are already available. Some useful specifications for piping materials will be found in the 1926-1927 report on station piping of the prime movers committee, N. E. L. A. The various forms of flange joints have been described in the technical press.

Expansion is one of the most difficult problems in pipe design when both high pressure and high temperature are used. Many excellent papers, among which are those of W. H. Shipman on "Design of Steam Piping to Care for Expansion," A. S. M. E., 1928; of A. M. Wahl on "Stresses and Reactions in Expansion Pipe Bends," A. S. M. E., 1927, and of Crocker and Sanford on "The Elasticity of Pipe Bends," A. S. M. E., 1922, discuss in a comprehensive manner the stresses and re-



Corrugated Expansion Bends as Made in England

actions that occur in piping. These papers deserve careful study by designers of high pressure piping.

It was said in Europe last summer that pipe bends carrying steam at 2,500-lb. pressure, 800 degrees F. temperature, had proved much less flexible than anticipated and that this stiffness had led to turbine troubles due to strains resulting from the pipe thrust. The form of pipe bend with corrugations rolled in while hot, is said to have provided much greater flexure than plain pipe bends in European plants and without appreciably increasing pressure drop. This bend has not been used extensively in America.

Flexibility may be obtained by dividing the main steam supply into a series of smaller pipes with bends of liberal radius. This scheme is used by some turbine builders to ensure that the stresses on the turbine casing from the high pressure pipe line are a minimum. In general, the runs of main piping must be as short as possible. When 1,200-lb. pressure or over is used, the high pressure turbo-generator may be placed adjacent to the boiler to decrease piping.

**Table II**

Increase in Steam Pressure for 3 Per Cent Steps in Thermal Efficiency.

Basis.—700 degrees F. total temperature. 29-inch. vacuum, 4-stage feedheating. Including boiler and condenser auxiliaries.

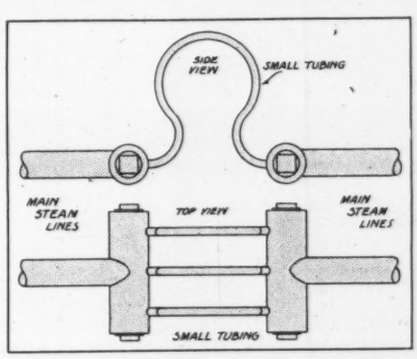
| | Per Cent | | | | |
|---|---|---|---|---|---|
| Increase in thermal efficiency | 3 | 6 | 9 | 12 | 15 |
| Initial Pressure | Final Pressure | | | | |
| From 200 lb. per sq. in. g. to | 265 | 365 | 505 | 764 | 1,360 |
| From 250 lb. per sq. in. g. to | 342 | 472 | 703 | 1,200 | ..... |
| From 350 lb. per sq. in. g. to | 495 | 755 | 1,390 | ..... | ..... |
| From 500 lb. per sq. in. g. to | 785 | 1,530 | ..... | ..... | ..... |
| From 750 lb. per sq. in. g. to | 1,470 | ..... | ..... | ..... | ..... |
| Reduction in coal consumption, per cent | 2.92 | 5.66 | 8.26 | 10.71 | 13.04 |

For 900 Degrees F.:
- Gain with pressure as above between 200 lb. per sq. in. and 750 lb. per sq. in.
- Gain with pressure increased by 1/6 per cent per 100 lb. per sq. in. between 750 lb. per sq. in. and 1,400 lb. per sq. in.

For 28-inch Vacuum:
- Gain with pressure increased by 0.3 per cent per 100 lb. per sq. in. between 200 lb. per sq. in. and 750 lb. per sq. in.
- Gain with pressure increased by 0.2 per cent per 100 lb. per sq. in. between 750 lb. per sq. in. and 1,400 lb. per sq. in.

## Conclusions

Present experience with high pressure plants has developed no really serious troubles with valves, fittings or piping of proper design for pressures up to 1,400-lb. and temperatures of 750 degrees F. The requirements for piping at higher pressures and temperatures are now recognized and can be fulfilled by the use of alloy steels. Steam temperatures will inevitably be increased when satisfactory materials for superheaters, piping and turbines are available. One can, therefore, plan for the use of such steam conditions with assurance of satisfactory operation of piping if reasonable care is exercised in its design, inspection, and erection.




Sketch Showing Use of Small Tubing for Expansion Bends on High Pressure Steam Mains.

# District Heating

## Principal Factors in Correct Installation

*By* B. M. Conaty

ONE of the essential differences between heating from a district plant and from an individual boiler lies in the fact that in the first instance, steam at constant pressure is supplied from the outside source whereas from the small individual boiler, the pressure varies continually. With the latter system, a fire is built up in the boiler and heat is generated at a rate in excess of the consumption resulting in the storage of heat in the system as well as in the building.

Steam from the district system, on the other hand, is available in unlimited quantities and at a uniform pressure. It can be consumed continuously or can be shut off by the turn of a valve. The aim should be so to adjust the system that only the amount equivalent to the normal heat loss from the building is admitted. Such operation is entirely possible.

District heating companies spend a great deal of money to effect proper insulation of the delivery lines and their examples should be followed by the consumer to the extent of adequately insulating all steam piping to prevent radiation losses within the building. Equal care should be used in the choice, location, and installation of the heating specialties so that maximum efficiency and economy may be obtained and the aim of this article is to assist through the heating and ventilating engineers and contractors, both the consumer and the heating company in reaching this objective.

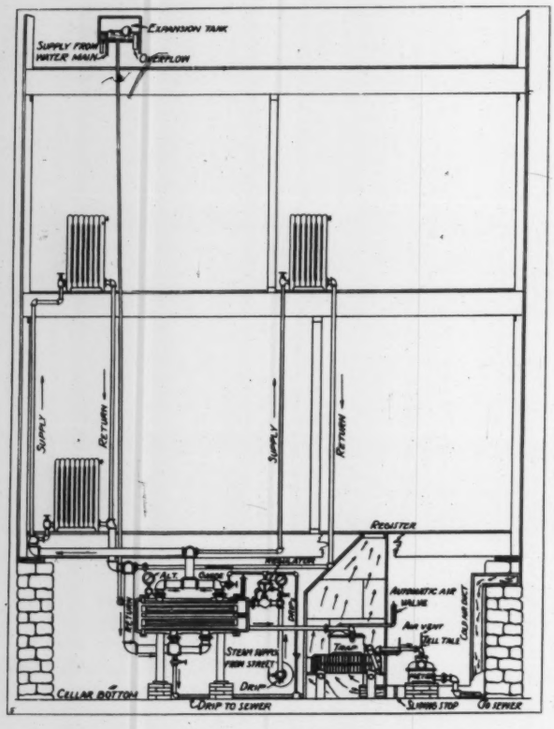



FIG. 1.—DISTRICT HEATING WITH HOT WATER IS ACCOMPLISHED BY THE USE OF A TUBE HEATER OR CONVERTER

A typical layout for a building which is heated from a district system is shown in Fig. 3. The essential difference between this and the ordinary individual boiler system in so far as the specialties are concerned, lies in the reducing valve, the steam inlet valve and gauge on the inlet end, the condensation receiver, condensation meter and traps on the outlet side.

### How the System Should Be Installed

In the installation of these specialties, accessibility should be considered as a primary requisite. It is frequently possible, during mild weather, to shut off the steam completely for a period of several hours during the day or night, and since marked economy can be effected by this means, the steam supply valve should be so located that this is convenient for the consumer.

Similarly the reducing valve should be located so that it can be inspected periodically and adjustments made when necessary. Commonly, certain regulations are established for the installation of such fittings and these should be followed carefully in making the installation. A gauge should be installed on the low pressure side of the reducing valve to facilitate setting the valve at a pressure suitable for economical operation.

The usual basis for the sale of heat is the amount of

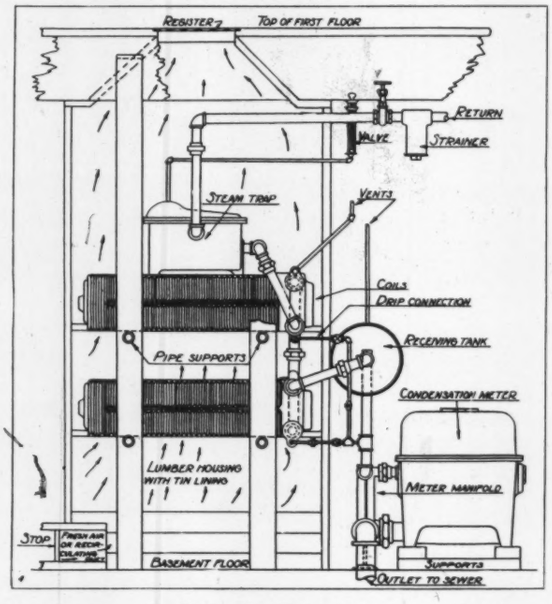



FIG. 2.—ECONOMY, IN MANY CASES, CAN BE EFFECTED BY THE USE OF AN ECONOMIZER

steam condensed in the building system during each month. This is measured by the installation of a condensation meter at a point toward which all return lines grade. The meter should be accessibly located with a view to easy reading and, if possible, adjacent to a sewer to which the measured condensation is to be discharged. Here, also, regulations of the local heating company govern the installation and should always be observed.

A typical gravity installation is shown in Fig. 4. The return lines from the various parts of the building discharge into a pipe receiver and a water seal. A strainer

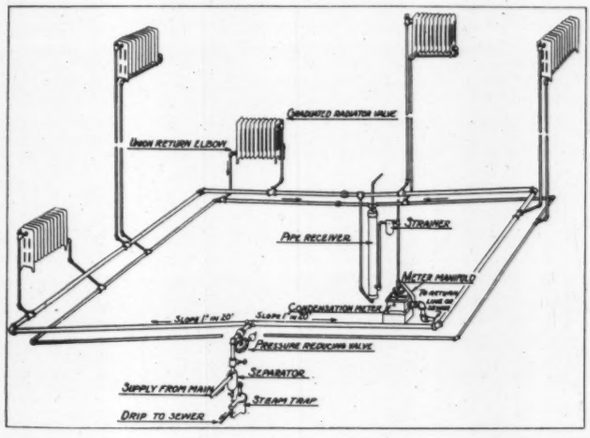



FIG. 3.—A TYPICAL LAYOUT FOR A BUILDING WHICH IS HEATED FROM A DISTRICT SYSTEM

is installed between the receiver and the meter. In a vacuum system, the return line discharges through a trap equipped with a thermostatic air by-pass such as is shown in Fig. 5.

### Direction for Setting Condensation Meter

The following directions for the installation of the meter can be used as a guide regardless of the type of meter used:

1. Connect meter to outlet of trap at the lowest point of the piping system or to outlet of vented tank or receiver.

2. Set the meter level both ways on a rigid foundation.

3. Install meter so that counter dial may be read conveniently.

4. Locate meter as near as possible to the point of discharge so that the discharge pipe, from the meter, will not exceed ten feet in length.

5. Place meter two feet or more above sewer inlet, whenever possible, in order to provide free gravity discharge. If meter discharges in return pipe, arrange installation so that the discharge from the meter is unretarded and cannot flood the meter under any conditions.

6. Always make piping from discharge opening of meter as large as the outlet openings in the meter. Two outlet openings are provided in the lower portion of the meter case, either or both of which may be used. It is generally advisable to use both discharge openings when the meter is placed in a building where steam is usually consumed in small quantities during the night or certain other hours and where overloads occur during the heating-up hours when slugs of condensate may reach the meter.

7. Place a strainer in inlet pipe to meter to prevent foreign matter from entering the meter.

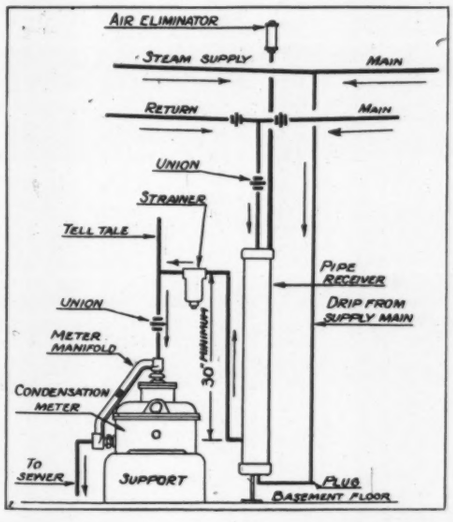
8. See that feed lines to the meter are properly trapped to prevent steam pressure reaching the meter at any time.

Here, also, accessibility, solid foundation, and careful installation are necessary for the entire satisfaction of both the owner and the heating company.

### Why an Economizer Should Be Used

It can well be pointed out that all steam lines should be insulated carefully and efficiently so that there will be no steam wasted. Heat from the district system is concentrated and most economical results can only be obtained by preventing the condensation of steam at all points except in the radiators where it is put to useful work. The return lines need not be covered as it is desirable to extract as much heat as possible from the condensation before it reaches the meter.

Economy, in many cases, can be effected by the use of an economizer such as is shown in Fig. 2. This consists of an indirect hot water radiator, arranged so that all condensation from the system must pass through it. The economizer usually is housed in such a way that air is admitted below the radiator and heated as it rises to an



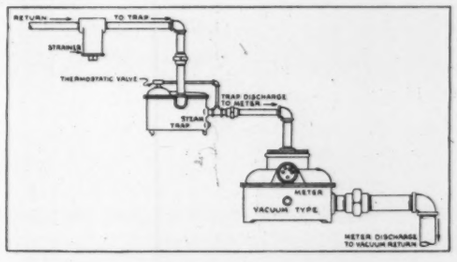
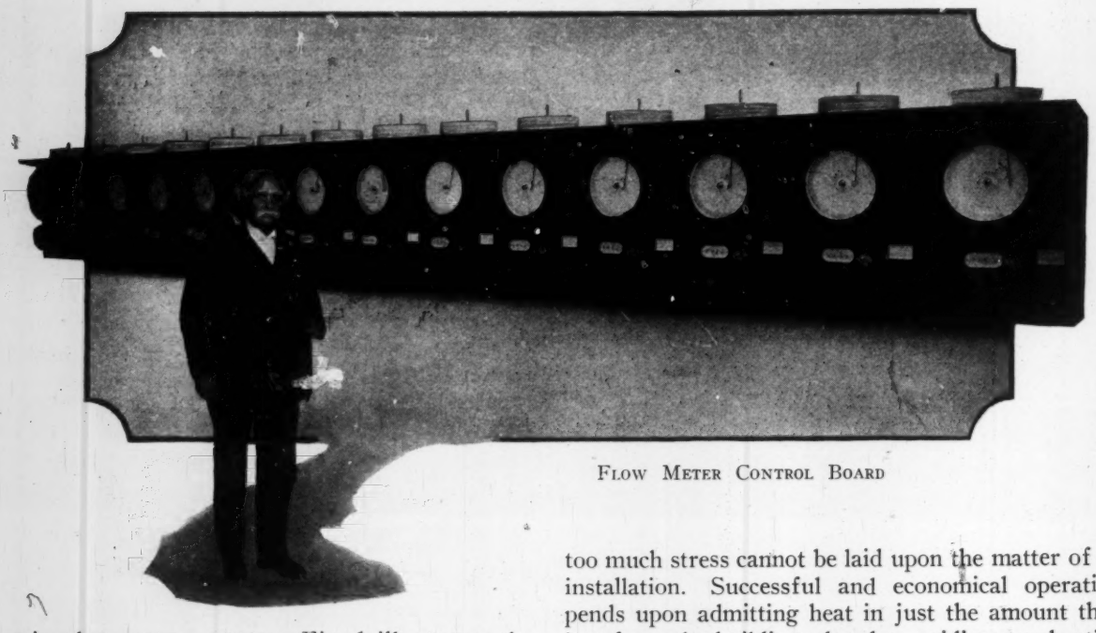




FIG. 4.—LEFT.—A TYPICAL GRAVITY INSTALLATION. FIG. 5.—BELOW.—THE RETURN LINE DISCHARGES THROUGH A TRAP IN A VACUUM SYSTEM

outlet duct in the floor of a hallway or other room in which the heat can be dissipated economically. This economizer serves a twofold purpose, that of utilizing the heat in the condensation and, at the same time, cooling the water before it is discharged into the meter.

### District Heating with Hot Water

Buildings are also commonly heated from an outside



FLOW METER CONTROL BOARD

source using hot water systems. Fig. 1 illustrates the common method of installing a tube heater or converter which is substituted for the boiler in the usual individual plant system.

In all cases of service from a district heating system, too much stress cannot be laid upon the matter of careful installation. Successful and economical operation depends upon admitting heat in just the amount that it is lost from the building, thereby avoiding overheating and consequent loss. The uniformity of pressure facilitates this and with well insulated, properly laid out systems and high grade specialties, economy and wonderfully satisfactory heating results are obtainable.

# District Heating School at Purdue University

ARRANGEMENTS have been made with Purdue University, Lafayette, Indiana, for the holding, May 20-25, of the third district heating school to provide thorough instruction in district heating subjects for anyone interested in this industry.

Only one course will be given this year. This course will be similar to the second course as given last year. A departure will be made from last year's procedure by having several men from district heating companies give some of the lectures. The course will in general cover the following:

Accessory apparatus for district heating.

Principles governing the flow of fluids.

Meters—testing methods, practices and policies.

New methods of steam heating.

The flow of steam in pipes.

Principles underlying the design and construction of underground distribution structures.

Heat losses from the distribution system and their prevention.

Welding.

Methods of estimating steam consumption and maximum demand.

Some questions in distribution system design.

The theory of rates.

A discussion of the various methods of charging in use in district heating.

Discussion and solution of course problems.

The ideas behind heat utilization work.

Customer's relation work.

Applicants should have a grade school or high school training, but need not be college graduates. The subjects will be arranged to the best advantage of the students and the class will be small enough so that a certain amount of individual instruction will be available. Anyone interested in the subject of district heating is invited to enroll. Membership in the National District Heating Association is not required.

The school will start on Monday, May 20, 1929, at 10:00 a. m. and will continue through Saturday noon, May 25.

The following instructors will have charge:

From Purdue University—

A. A. Potter, dean, schools of engineering.

J. D. Hoffman, head, department of practical mechanics.

A. W. Cole, professor of steam engineering.

C. H. B. Hotchkiss, assistant professor of heating and ventilating.

H. L. Solberg, assistant professor of mechanical engineering.

From the district heating industry—

J. C. Butler, Illinois Maintenance Company, Chicago.

D. S. Boyden, Edison Electric Illuminating Company, Boston.

J. W. Meyer, Philadelphia Electric Company, Philadelphia.

S. S. Sanford, The Detroit Edison Company, Detroit.

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# Air Conditioning System of a Detroit Office Building

*By* Hiram L. Walton[1] and Leslie L. Smith,[2] Detroit, Mich.
*MEMBERS*

FIG. 1 — UNION TRUST BUILDING, DETROIT

SIXTEEN stories and two basements of the Union Trust Building in Detroit are heated and ventilated throughout by a combined air conditioning and heating system. Some air conditioning of office buildings has been done in the Southwest and provision has been made for it in some recent buildings in other localities, but it is believed that its application to an office building as a combined system and to the extent that occurs in the Union Trust Building would make a description of this installation and considerations affecting its design and operation of interest to the profession.

The Union Trust Building (Fig. 1) is 80 ft. wide by 270 ft. long on the ground. It is 40 stories in height above grade and has three basements below grade. There are street exposures on the north and south ends and west side and an alley exposure on the east side. The National Bank of Commerce affiliated with the Union Trust Co. occupies the first five floors. The lower banking room is on the first floor and the main banking room is on the second floor and extends in clear height through four stories of the building. Both of these banking rooms are open to the lobby, which is nearly as high as the main banking room and is separated from it for its full width and height (Fig. 2) only by an open grille.

The first basement is occupied by the safety deposit and security vaults and the second basement by the record vaults and filing departments. There is a relatively large working population on this latter floor. The Trust Company's offices occupy the seventh to fifteenth floors inclusive and part of the sixth. Provision has been made for the future occupancy of the sixteenth floor.

The space occupied by the Bank and Trust Co. including the basements and sixteenth floor is provided with a combined air conditioning and heating system. By an air conditioning system is meant, a ventilating installation that is capable of supplying a warmed and humidified air in winter and a cooled and dehumidified air in summer accordingly as the

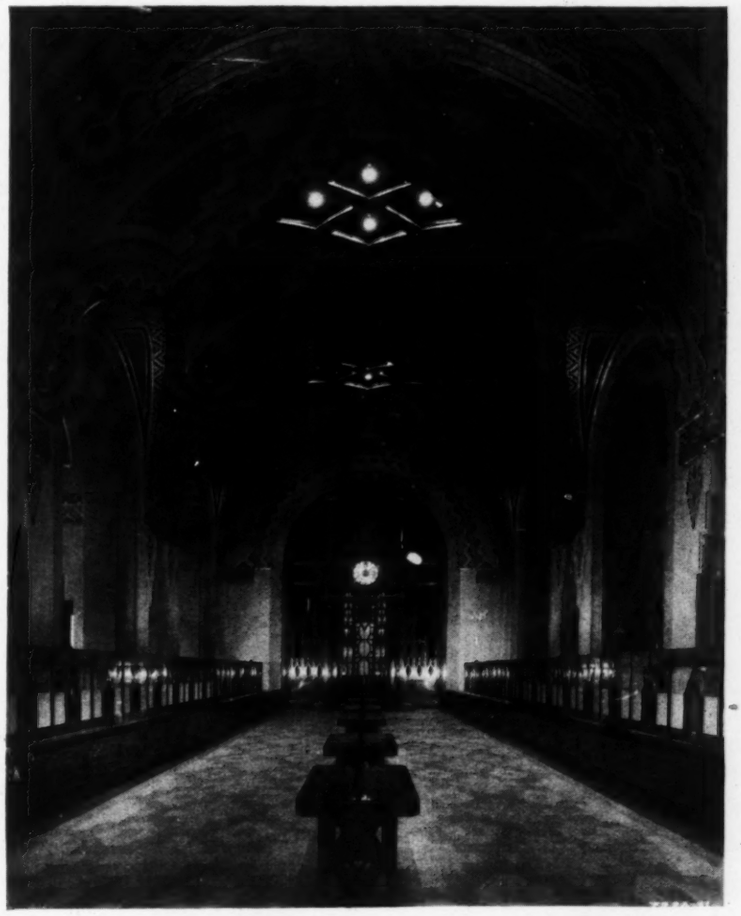

FIG. 2—MAIN BANKING ROOM WITH SUPPLY GRILLES ON COLUMNS

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For presentation at Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Bigwin Inn, Lake-of-Bays, Ontario, Canada, June 1929.

comfort of the occupants may require. This is further termed a combined heating system when the air is delivered at such temperature as to adequately heat the space supplied. Direct radiation has been installed in the toilets and stairways of the floors in question, but the air conditioning system is depended on for heating the remainder of the space. The space above the sixteenth floor is rental space and is heated by direct radiation of a semi-concealed type.

The location of the safety deposit vaults and the record vaults and filing departments below grade in the first and second basements required a mechanical system of ventilation for these areas for any condition that would be at all satisfactory to the occupants and customers. The first floor banking room has a large number of people on the floor at various times, and this area being only of normal height, 15 ft. at the center, mechanical ventilation became a necessity. The main banking room on the second floor is probably of such height and volume that, insofar as ventilation is a necessity, a local air movement within the room might suffice, even though the number of people within this room is considerable during the banking hours. As a convenient means of heating this room and accommodating the heating equipment to the architectural design and treatment, a blast system which in extent and arrangement would correspond to a ventilating installation was found preferable. In the Trust Company's offices there is a large working population amounting to a density in some areas of as much as one person to 50 square feet of floor area. The Trust Company had been experiencing an increasing crowded condition in their previous quarters for some time, and their records indicated that the percentage of lost time from illness of employees increased in proportion to the number of employees that were added in any area when only natural means of ventilation were provided. A comparison with ordinary standards of ventilation further showed that many departments of the Trust Company could not effectively utilize the space assigned to them if they had to depend on natural and window ventilation. It was evident that a ventilating installation would be required for both the Bank and Trust Company's quarters.

The necessity of a ventilating system having been established, the question that now required consideration was whether or not this ventilating system should be an air conditioning installation. The additional investment and operating costs could be estimated within such limits as would be required for factors affecting the adoption of air conditioning.

TABLE 1—AIR CONDITIONING OPERATING COSTS

| | |
|---|---|
| BASIS | |
| Capacity of refrigeration plant | 600 tons |
| Hours of operation assumed as | 500 hours |
| POWER CONSUMPTION | |
| Compressors (connected load) 650 h.p. | |
| Pumps 90 h.p. | |
| Total connected load 740 h.p. | |
| Kilowatt Input 555 k.w. | |
| 500 hours @$0.02 per kwh | $5,550.00 |
| REFRIGERANT | |
| $CO_2$ @ 25 lb. per ton per season @ $0.08 per lb. $600 \times 25 \times .08 =$ | $1,200.00 |
| CONDENSING WATER | |
| Cost of water: $0.40 per 1,000 cu. ft. Consumption based on 2.9 gal. per min. per ton with condensing water @ 70 deg. fahr. $600 \times 500 \times 60 \times \frac{2.9}{7.5} \times \frac{.40}{1000}$ | $2,790.00 |
| MISCELLANEOUS | 60.00 |
| | $9,600.00 |

The additional investment was estimated at $130,000.00. The operating costs, exclusive of maintenance (Table 1), were estimated at $9,600.00 per year. Allowing annual fixed charges, including maintenance at 11 per cent,[3] the total annual cost of

[3] Interest 6 per cent, amortization 1.5 per cent, taxes 1.5 per cent on full value, insurance and liability 0.5 per cent, maintenance 1.5 per cent, total 11 per cent.

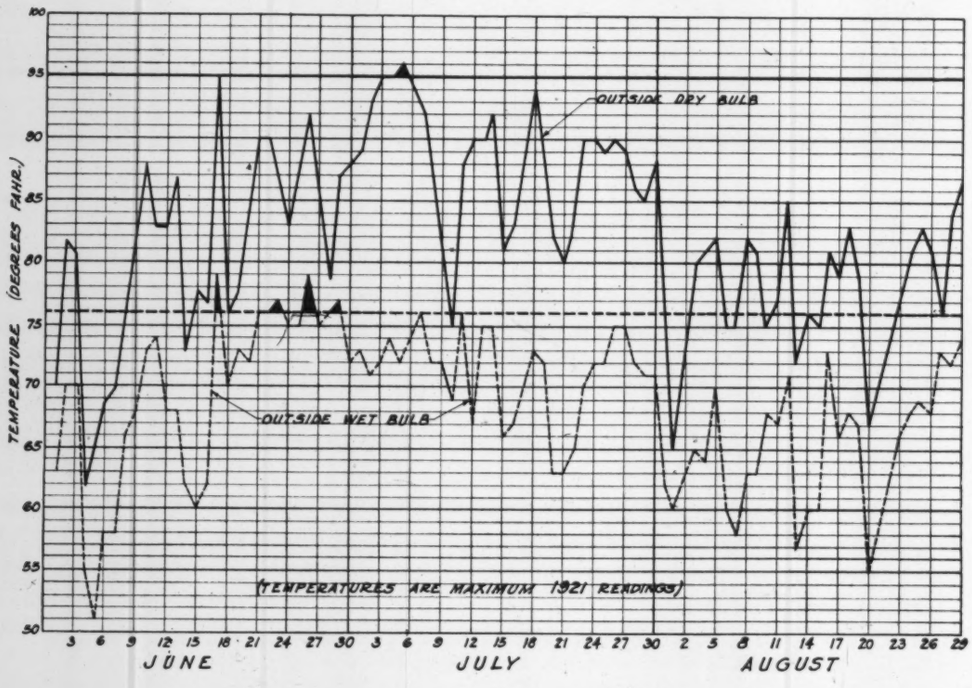


FIG. 3—OUTSIDE TEMPERATURES AT DETROIT

the air conditioning feature over that which straight ventilation would have cost, amounted to $23,900.00. It will be noted that the operating costs do not include any item for attendance, it being concluded that the air conditioning would not result in any additions to the operating force.

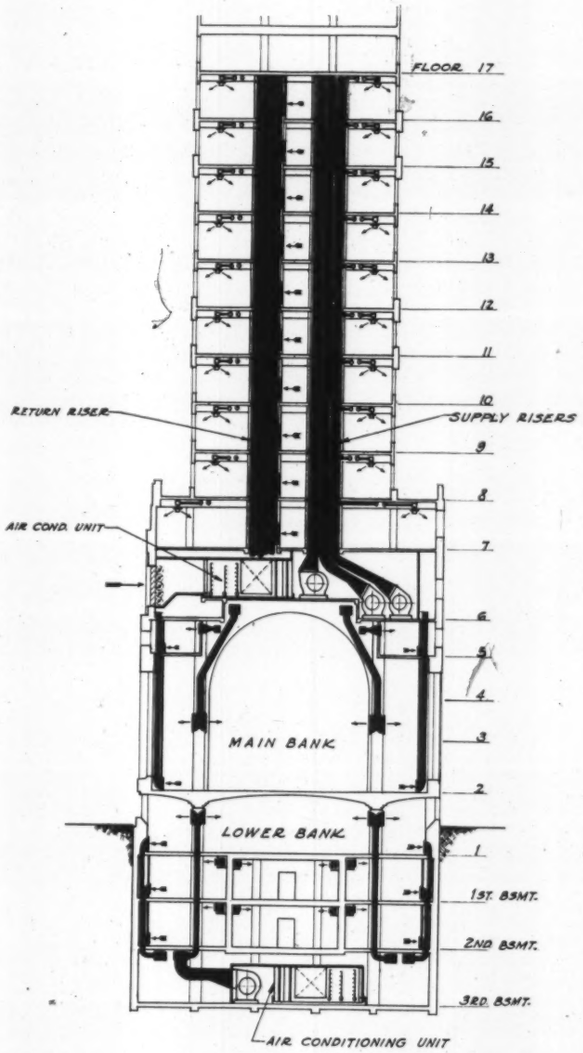


FIG. 4—CROSS SECTION THROUGH AIR CONDITIONED AREAS

It is not feasible to give a dollars and cents value to the advantages of air conditioning to compare with the additional investment and operating costs. Outside of industrial plants, the widest use of air conditioning has been by theatres and department stores, and primarily for the purpose of attracting trade.

The Bank and Trust Company were not oblivious to the comfort of their customers, and it was recognized that an air conditioning installation would also have some advertising value for these institutions, but it was believed that comfort for their employees and working conditions that would contribute most to their health and efficiency were considerations that gave the greatest opportunity for return on any investment that might be made. It was further recognized that there was some element of perfection in having air conditioning, and which would not be out of keeping with the building and its appointments and the standard of business conducted in it. All features considered, it was concluded that it was well worth while to have the air conditioning at the investment and operating costs that would be incurred.

The conditions to be maintained in the building were established at a temperature of 70 deg. fahr. and a relative humidity of 40 per cent during the heating season, and during the summer a temperature not exceeding 80 deg. fahr and a relative humidity not exceeding 55 per cent when the outside dry bulb temperature was 95 deg. fahr. and the outside wet bulb temperature was 76 deg. fahr. In arriving at these outside conditions, a chart was constructed typical of summer conditions for this vicinity. This chart is shown in Fig. 3. It will be noticed that the areas above the 95 deg. dry bulb line and 76 deg. wet bulb line, representing the degree days that the system would not be able to maintain the standard set, are very small. Normally for department stores and theatres in this locality, these limits are set lower (84 deg. dry bulb and 73 deg. wet bulb) and greater areas are tolerated.

The air conditioning installation for the spaces previously defined consists of three separate systems: First—a system serving the first floor bank, main lobby, and vaults and work spaces occupying the first and second basements; second—a system serving the main banking room and office space below the seventh floor; third—a system serving the office floors of the Trust Company. These systems are hereinafter referred to as lower bank, main bank, and office systems respectively. The capacities of these three systems are given in Table 2.

TABLE 2—CAPACITY OF INSTALLATION

| SYSTEM | LOWER BANK | MAIN BANK | OFFICE |
|---|---|---|---|
| Volume of space served (cu. ft.) | 456,500 | 480,000 | 1,590,000 |
| No. of people | 450 | 410 | 2,610 |
| Air supplied (CFM) | 69,000 | 74,000 | 150,000 |
| No. of conditioning units | 1 | 2 | 2 |
| Air changes per hour | 6.6 | 9.2 | 5.7 |

The air conditioning unit for the lower bank system is located in the third basement. The air is supplied (Fig. 4) at the ceiling of the space served and withdrawn from near the floor and thence returns to the conditioning unit. The two conditioning units for the main bank system are located in the machinery room on the sixth floor. This space is formed by the deep trusses carrying the stories above the main banking room and the walls resulting from fireproofing the trusses form the enclosures for the air conditioning units. The admission of air and provisions for recirculation are similar to those for the lower bank system. For the heating of the space served by these two systems, several heating units of the fin-tube type have been installed in the supply ducts. There is a separate heater for each section of the space served whose heating requirements are expected to vary from that of other sections.

The arrangement of these two systems with their

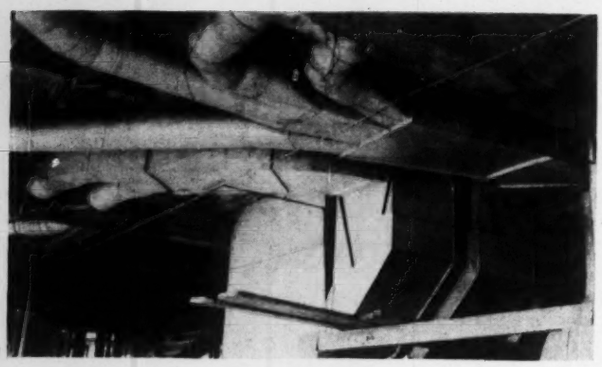

FIG. 5—HEATERS AND DISTRIBUTING DUCTS

supply and recirculating ducts, the velocities in them and outlet velocities, follow very closely that which may be considered standard practice. It was feared that with the high banking room open to the lobby, and with the elevators opening to this lobby, there might be objectionable drafts, and that it might be necessary to install a glazed partition between the main bank and lobby. Although the performance has not been observed under extreme conditions, the indications are that objectionable drafts will not be experienced.

The office system serving the 7th to 16th floors, inclusive, has two air conditioning units installed in the 6th floor machinery room, similarly to those for the main bank system. One of these units serves the North half and the other the South half of these floors. The South unit serves a space having three exposures,—namely, East, South and West. A separate fan, with its supply duct system, has been provided for each exposure, the purpose being to have the system of ducts for any one exposure uninfluenced by variations in the leakage and wind pressure affecting the air supplied by the duct system for any other exposure. It is expected the flexibility of this arrangement will also be of advantage in summer conditions in compensating for the changing sun effect on the sides of the building. A heater (Fig. 5) has been installed on each floor for each duct system, which can be controlled to give air of the proper temperature to meet the heating requirements.

The air conditioning units (Figs. 6 and 7) for the office system are typical in their arrangement and operation of those for the three systems comprising the complete installation. These units draw outdoor air in through louvres at the sixth floor level. They also draw recirculated air back through the return air shafts connected to return air grilles on the various floors. Both the outdoor air and the return air enter a common chamber ahead of the dehumidifier where they are mixed to maintain a temperature above freezing. Part of the mixed air then passes through blast heaters and through the dehumidifier where it is washed and cleaned and its moisture content definitely fixed. The remainder of the mixed outdoor and return air by-passes the dehumidifier and enters the unit on the fan side. In the summer time the dehumidified air and the by-passed air are then mixed to obtain the required conditions of air delivered to the rooms. The dehumidifying is accomplished by $CO_2$ direct expansion coils installed as part of the air conditioning unit. During the heating season the process is the same except that the air is humidified.

By running two ducts in place of one for a part of the distance, it was found that the distributing ducts (Fig. 8) on each floor could be kept within a maximum diameter of 12 in. where they crossed the floor beams. It was further found that structural considerations required these beams to be 22 in. in depth, and that if they were made 24 in. in depth and a joist floor construction used, that the 12 in. ducts could run through the webb of the beams (Fig. 9), effecting a very considerable saving in the cost of the structure over that which would have been required if the ducts had had to run under the beams. These distributing ducts terminate in a ceiling outlet, there being a double outlet for each bay, such that the usual office partitions can be run through the outlet if division of the office space at any time requires it. These outlets have a damper for adjustment of the air quantity and a simple diffusing head for directing the air flow along the ceiling. No provision is made for the occupant having any control whatever over the quantity of air supplied to his office or over its temperature.

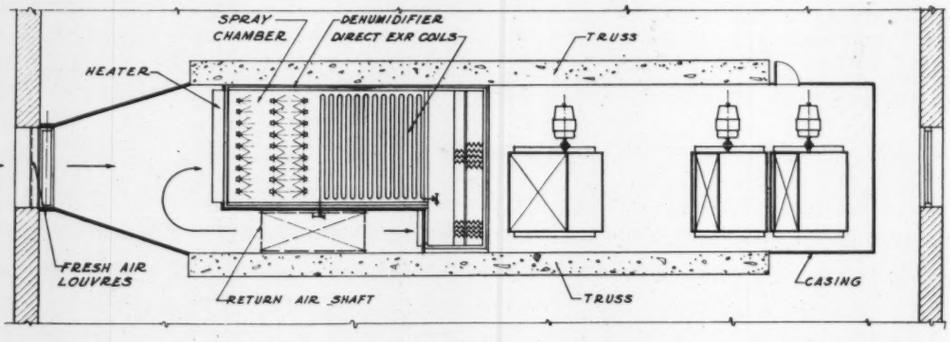


FIG. 6—PLAN OF AIR CONDITIONING UNIT

The office system varies from the bank systems in the provisions for recirculation. There is no system of recirculating ducts other than the recirculating riser to the unit at each end of the building. There are recirculating grilles in the office partitions, located in general near the floor so that the air supplied to the office can in part find its way to the corridor and thence to the recirculating risers. Some sacrifice in office privacy has resulted from the installation of these grilles, but in general the owners

have felt that they could well tolerate it for the simplification and saving that it effected. In some offices and departments where this loss of privacy was considered objectionable, double grilles have been provided with sound-proofing between them.

With the occupant of an office having no control over the quantity of air supplied or over its temperature, some other provision had to be made for room temperature control. By providing on each floor a sub-duct system for each exposure and providing that system with its own heater, it was expected that, if the system was once adjusted for a proportionate air supply to each office, and if this air was supplied at proper temperature to one office for maintaining the room temperature, it would be of proper temperature for the other offices on the same duct system. On this basis a thermostat has been installed in a typical office for the control of the heater on a duct system. The effect of variation in the air supply due to wind pressure building up a counter pressure on any portion of the space supplied, has been minimized by carrying a relatively high static pressure on the system. Provisions for adjusting for such a condition have been further made by driving the fans, there being a fan for each exposure as above described, with variable speed motors. The occupants are not only prevented from interfering with the operation of the system itself, by adjustment of the quantity and temperature of the air supplied, but they are also prevented from upsetting exposure and leakage conditions by opening windows. All windows on the office floors are provided with keyed locks and are locked closed.

It is felt that the heating of several separate rooms or offices from the same duct system by one heater without means of varying the amount of heat supplied to the various rooms is somewhat experimental even though those rooms may be subject to the same exposure conditions. However, the heating of an office building by a blast system was not untried. Such an installation had previously been completed for the addition to the Detroit Edison Co.'s office building and although of the double duct type, had well demonstrated the practicability and advantages of this means of heating. It was concluded that some greater variations in the average room temperature than is ordinarily considered good temperature regulation might well be tolerated if omission could be accomplished of the usual system of direct radiation. This radiation occupies valuable floor space and subjects those, who must work in proximity to the radiator, to an uncomfortable baking on one side from the radiant heat—hardly consistent with the conditions for an air conditioned area.

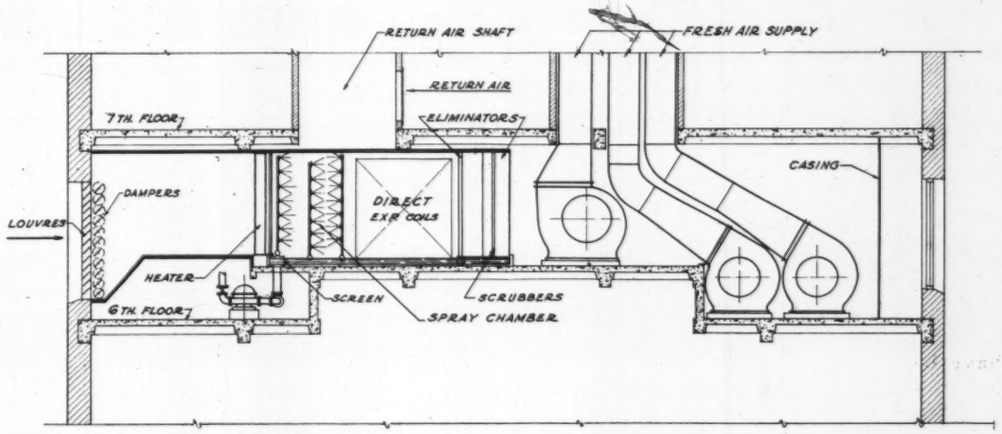


FIG. 7 — SECTION THROUGH AIR CONDITIONING UNIT

There was furthermore a saving effected in omitting the direct radiation system that was available in offsetting the cost of the ventilating system. 20,130 sq. ft. of radiation was omitted which in the form of ordinary wall-hung exposed radiation would have cost $35,000.00. Presuming that this radiation would have been made the semi-concealed type as was done in the rental space the cost would have been increased for the additional radiation, enclosures, and provisions in the building construction for them, by $16,000.00. The cost of the heater installation replacing the radiation amounted to $26,000.00, making a net saving of $25,000.00.

The work carried on in finishing the building and

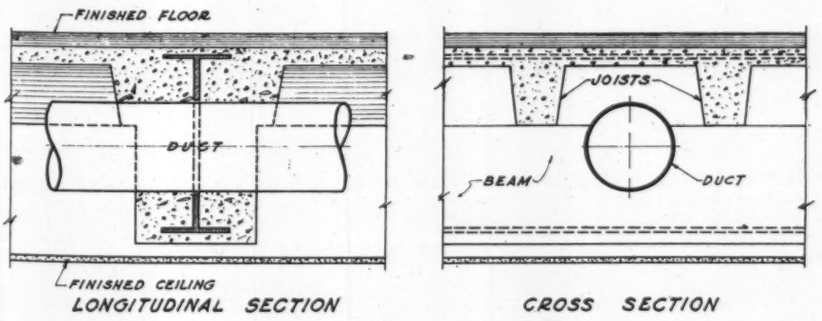


FIG. 8—ARRANGEMENT OF DUCTS AND FLOOR CONSTRUCTION

in moving in has resulted in conditions in the areas served that have made it impractical to obtain more than a preliminary adjustment of the air conditioning installation since its completion. The final adjustments are now being made, and although these have been under way less than a week at this writing, the indications are that difficulty will not be experienced in operating the installation to heat or cool the various rooms within a variation of temperature that will be satisfactory.

The designers of this installation were greatly assisted in perfecting its arrangement and details by the engineers of the B. F. Reynolds Co. and American Carbonic Machinery Co., who made the installation, and by the engineers of other air conditioning companies who gave so freely of their time and experience during the stages of development. The designers are also not unappreciative of the opportunity that was given them by the progressiveness of the building owners.

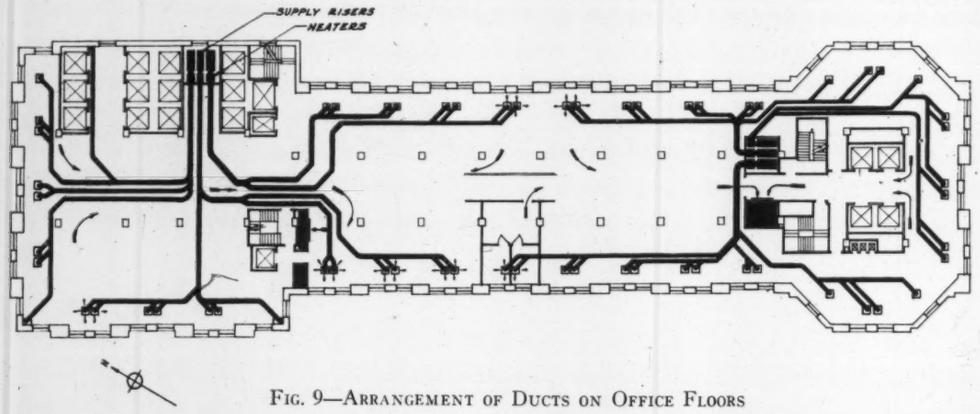


FIG. 9—ARRANGEMENT OF DUCTS ON OFFICE FLOORS

# Code of Minimum Requirements Issued to Members

In accordance with the resolution of the Council, members of record and in good standing during 1928 will receive a binder for A. S. H. V. E. Codes and Standards, which will contain the fourteen sections of the Code of Minimum Requirements for the Heating and Ventilation of Buildings.

The Code of Minimum Requirements, in fourteen separate pamphlets, is the result of five years effort by L. A. Harding and his Committee and the Code as published, is the culmination of many years effort for the benefit of the public.

Each section was prepared by a Sub-Committee and the following subjects are covered:

Section I—Minimum Ventilation Requirements for Public Buildings.

Section II—Minimum Requirements for Estimating the Heat Required for Warm Buildings.

Section III—Minimum Requirements for the Determination of the Amount of Direct Steam and Hot Water Radiating Surface to be Installed in Steam and Hot Water Heating Systems.

Section IV—Minimum Requirements for the Determination of the Amount of Indirect Steam or Hot Water Radiating Surface to be Installed in Indirect Gravity and Fan Circulation Heating and Ventilating Systems.

Section V—Minimum Capacity and Installation Requirements for Low Pressure Steam and Hot Water Heating Boilers.

Section VI—Minimum Requirements for the Design and Installation of Warm Air Furnace Heating Plants.

Section VII—Minimum Requirements for the Design and Installation of Chimneys or Stacks for Steam Boilers, Hot Water Boilers and Warm Air Furnaces.

Section VIII—Minimum Requirements for Pipe Sizes for Use with Low Pressure Steam, Vapor and Vacuum Heating Systems.

Section IX—Minimum Requirements for Pipe Sizes for Use with Gravity and Forced Hot Water Heating Systems.

Section X—Minimum Requirements for the Design and Installation of Air Ducts, Inlets and Outlets, in Conjunction with Fan Air Circulation, and the Installation of Ventilating Fans for Use with Steam and Hot Water Heating and Ventilating Systems.

Section XI—Minimum Requirements for the Installation of Air Washers and Filters.

Section XII—Pumps for Heating and Ventilation Equipment.

Appendix I—Formulaa for Physical Units, Air and Vapor Mixtures, etc.

Appendix II—Standard Symbols for Heating and Ventilating Drawings.

The Code as published consists of 158 pages and is fitted into a loose leaf binder with flexible cover.

The Code represents *minimum requirements* as called for by good engineering practice and is so written that it may be incorporated as a part of a Municipal Building Code, if found desirable.

Great credit is due to the men who have given their time unselfishly and the Society owes a debt of gratitude to the Sub-Committee Chairmen who labored so long and earnestly to produce the Code.

The men who assisted Mr. Harding were: E. Vernon Hill, Chicago, A. C. Willard, Urbana, Ill., R. V. Frost, Norristown, Pa., L. C. Soule, Newark, N. J., J. F. McIntire, Detroit, J. D. Hoffman, Lafayette, Ind., J. R. McColl, Detroit, J. A. Donnelly, Largent, W. Va., W. S. Timmis (deceased), New York City, C. A. Booth, Buffalo, W. H. Carrier, Newark, N. J., Perry West, Newark, N. J., F. Paul Anderson, Lexington, Ky. and J. H. Walker, Pittsburgh.

Provision has been made so that the Code of Minimum Requirements for the Heating and Ventilation of Buildings is available together with flexible binder at the nominal cost of $5 per copy.

# Over-all Heat Transmission Coefficients Obtained by Tests and by Calculation

*The results of co-operative research work between the A. S. H. V. E. and the University of Minnesota*

*By* Frank B. Rowley[1], A. B. Algren[2], J. L. Blackshaw[3], Minneapolis, Minn.

ONE of the important factors in the problem of heat transmission through building materials and insulated walls is that of the relation between the overall coefficients as obtained by test and as determined by calculation for a built-up wall section. There are two coefficients commonly used to designate the thermal value of materials: the overall coefficient, and the thermal conductivity of the material. The first is generally designated by $U$ and gives heat transmission in British thermal units per hour per square foot of wall per degree difference in temperature between the air on the two sides of the wall. The second is designated by $k$ and gives the thermal conductivity of the material in British thermal units per square foot per hour per inch thickness per degree difference in temperature between the two surfaces. The difference between these coefficients is that the first one covers the full thickness of the wall giving the transmission from air to air, while the second one gives the transmission from surface to surface per inch thickness of the material. The first is applicable to built-up wall sections, and the second to the conductivity of homogeneous materials.

It is conceded that the conductivity, $k$, for a material is much more easily determined by test methods than is the overall coefficient.

In the first place, the apparatus commonly used is much less expensive to construct and the results may be obtained at a much less expense of time and material. The over-all coefficient is, however, the one necessary for finished buildings and it must either be determined by test or indirectly by calculation. If it is determined by calculation, the results must be sufficiently checked by tests to prove the correctness of the procedure.

The method of procedure and the type of apparatus for determining the thermal conductivity of homogeneous materials is fairly well standardized and accepted by the various experimenters. This consists, in general, of a hot and a cold plate between which the test material is placed, the hot plate being so arranged that the heat to the test specimen may be measured and the heat losses prevented by a special guard or balancing ring. The method for determining the over-all coefficients is not yet as commonly accepted. In general, there are two procedures possible; first by an actual test of the built-up wall section, and second, by calculation. Several types of test apparatus have been proposed and used. One type consists of some especially designed box and the other is some form of plate or meter placed in contact with the surface of the wall. In any case, if the results are to be of value, great care is necessary to prevent any unknown loss of heat and to obtain accurate measurements of temperatures and heat flow.

If the over-all coefficient is to be determined by calculation, there are several factors pertaining to the specific materials used in the walls which must be definitely known. Without these the results may be incorrect and misleading.

Some of the factors which enter into the calculation are as follows:

A. The thermal conductivities of the individual materials used.

B. The arrangement of these materials in the structure.

C. The conductivity of the air spaces within the wall.

D. The surface coefficients of the outer layer of the materials.

"*A*" The thermal conductivities of the materials are normally determined by the hot plate method. They depend upon the character of the material, density, moisture content and mean temperature. The conditions governing these values must all be considered if the conductivities are to be applied with accuracy to any particular wall. A common mistake is to use conductivities which were obtained for an entirely different mean temperature, moisture con-

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[2] Non-Member—Instructor in Mechanical Engineering, University of Minnesota.
[3] Member—Research Fellow, University of Minnesota, Minneapolis, Minn.

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tent or density than those at which the material is to be used in the wall.

*"B"* In considering the arrangement of materials, in the wall, such factors enter as the proximity of these materials to each other, the thickness of the particular material in the construction as compared to the thickness when tested, the blocking off of the air spaces and the occurrence of air circulation through the materials themselves. As examples of possible errors, a flexible, soft material which is rated at ½ in. thickness may be nailed between two layers of boards and brought down to less than ¼ in. in thickness. Materials which are porous in nature may be placed in a wall in such a manner that natural air circulation through the material will offset a large part of the insulating value. The application of the material may be such that heat is transferred around it by air currents. When any of these factors are present, the results obtained by calculation are misleading.

*"C"* The values assigned to the air spaces will vary depending primarily upon the thickness of the air space and the mean temperature. A common method has been to assign one value for all air spaces, which, in the light of recent experimental work, is incorrect. In selecting these values, it must be definitely known that the air space is a closed compartment and not open to communication with other air spaces of different temperatures.

*"D"* When considering the inner and outer surface coefficients of the wall, due regard must be given to the character of the surfaces, the nature and temperature of the surrounding objects and the wind velocity to be expected over the surfaces. For practical results the wind velocity is the most important factor to be considered.

From the foregoing it is evident that there are many elements which enter into the method of determining over-all coefficients by calculation. If, however, these elements are all definitely understood, and there are no other unknown factors as infiltration entering into the problem, the over-all coefficients may be calculated with accuracy, and the results will check with those obtained by accurate test methods. There are cases, however, for which calculations are difficult, due to complications of the structure, to air leakage, to changes in the form of material when applied, to poor workmanship, etc. In such cases these conditions must either be estimated for the calculations or else the constants must be determined by test.

There has been much controversy over the relative merits of the two general methods for determining the over-all coefficients. Some have advocated the test method and others that the constant be determined by calculation.

It is easy to find plenty of examples where both methods have given erroneous results. For this reason some engineers have taken the stand that there is no acceptable method for determining these over-all coefficients. In spite of the controversies which may exist, the fact is that accurate results may be obtained by either method when properly applied. If test methods are used, accurate instruments and methods must be employed, and if calculation is resorted to, the full conditions covering the specific properties of the materials and their application to the wall must be known.

It is not the purpose of this paper to discuss the relative merits of different types of test apparatus which have been used for determining overall heat transmission coefficients, but rather to consider the results as obtained by one specific type and to compare these to the results obtained for the same walls by analytical methods. The hot box apparatus was used to determine the overall coefficients and the

TABLE 1—DESCRIPTION OF INSULATION USED IN THE DIFFERENT WALLS

| Mark Designating Material | Description of Material | Wall in Which Used | Thickness as Used Inches | Density Lb. per Cu. Ft. | Conductivity k | Mean Temp. Deg. Fahr. |
|---|---|---|---|---|---|---|
| A | Semirigid board | 19 | 0.580 | 13.3 | 0.297 | 35.0 |
| | | 36 | 0.660 | .... | 0.300 | 40.0 |
| B | Wood fiber board | 10 outside | 0.520 | 15.2 | 0.315 | 30.0 |
| | | 11 inside | 0.526 | 14.4 | 0.330 | 62.0 |
| | | 11 outside | 0.527 | 15.1 | 0.315 | 30.0 |
| | | 34 | 0.526 | 15.0 | 0.318 | 40.0 |
| C | Felted wood fiber between two layers of craft paper | 12 | 0.750 | 4.8 | 0.253 | 40.0 |
| | | 16 | 0.625 | 4.8 | 0.250 | 35.0 |
| | | 53D | 0.750 | 4.8 | 0.253 | 40.0 |
| E | Animal hair lined on one side with tar paper and on the other with heavy craft paper | 15 | 0.36 | 9.7 | 0.238 | 40.0 |
| G | A cereal fiber board | 23 inside | 0.48 | 14.4 | 0.362 | 62.0 |
| | | 23 outside | 0.47 | 14.8 | 0.340 | 22.0 |
| | | 26 inside | 0.48 | 14.4 | 0.362 | 62.0 |
| | | 26 outside | 0.47 | 14.8 | 0.342 | 30.0 |
| H | Paper felt treated on the surfaces with creosote for water-proofing | 28 | 0.119 | 34.4 | 0.470 | 40.0 |
| J | A ground waste paper pulp held together with a binder and applied by air gun | 33 outside | 1.11 | 5.78 | 0.272 | 35.0 |
| | | 37 outside | 1.11 | 5.78 | 0.272 | 35.0 |
| | | 42 | 0.814 | 5.78 | 0.283 | 60.0 |
| K | Corrugated paper board | 8B | 0.209 | 11.7 | 0.374 | 40.0 |

hot plate to determine the conductivities of the individual materials. These were described in a paper entitled "Heat Transmission Research" and published in the American Society of Heating and Ventilating Engineers' Journal, July, 1928. The description of the apparatus will, therefore, be omitted.

For calculations the following well known formula was used:

$$U = \frac{1}{\frac{1}{f_1} + \frac{x_1}{k_1} + \frac{1}{a_1} + \frac{1}{a_2} + \frac{x_2}{k_2} + \frac{1}{f_o} + \ldots}$$

in which $U$ is the over-all heat transmission coefficient of the wall, $f_1$ and $f_o$ are the inner and outer surface coefficients of the wall, $x_1$ and $x_2$, etc. are the thicknesses of the various materials used in the wall, $k_1$ and $k_2$, etc. are the respective conductivities of the materials, $a_1$ and $a_2$ are the air space coefficients for the air spaces as occurring in the walls.

These factors were determined for the walls considered as follows. The conductivity of all insulating materials used was determined by the hot plate method. The conductance was determined for all combinations of materials as were used on the surfaces of the walls. Thus lath and plaster; sheathing, building paper and lap siding; sheathing, building paper and stucco were treated as separate units and the conductance determined for the mean temperatures at which they occurred in the walls. The air space coefficients were taken from the curves as previously determined and reported in a paper entitled Thermal Resistance of Air Spaces, American Society of Heating and Ventilating Engineers, Journal, January, 1929. The surface coefficients were taken as the average results obtained from many tests with the hot box. These surface coefficients are for an air velocity of about 0.6 miles per hour and place the calculated results on the same basis as the test results.

Table 2—Conductance of Specific Combinations of Material Used for Calculating the Overall Transmission Coefficients of Walls

| Materials | Mean Temperature | Conductance |
|---|---|---|
| ⅜" lath and ⅜" plaster | 70 | 2.50 |
| Fir sheathing, building paper and pine lap siding | 20 | 0.50 |
| Fir sheathing, building paper and stucco | 20 | 0.82 |
| Fir sheathing and building paper | 30 | 0.706 |
| Building paper and 4" pine lap siding | 15.5 | 0.854 |
| Conductance of ⅜" plaster | 73. | 8.8 |

The conductivities of the insulating materials used as determined by the hot plate for the mean temperatures corresponding to their position in the walls is given in Table 1. The conductance of the specific combinations of materials for mean temperatures at which these combinations occurred is given in Table 2. The surface coefficients as determined from tests and used in the calculations are given in Table 3. The air space coefficients as previously determined were taken from the curves of Fig. 1. A complete description of the walls tested and calculated is given in Table 4. The individual coefficients and factors used in calculating the overall coefficient for each wall are given in Table 5. The majority of these values were taken from Tables 1, 2 and 3 and the curves of Fig. 1, and compiled in Table 5 as a matter of convenience. The final results giving the relation between the calculated and test values are given in Table 6. It should be noted that in cases where a soft felted insulation was used the thickness was determined as accurately as possible after the material was in place in the wall. In the case of wall No. 15 this actually introduced an additional air space over part of the surface of the insulating material.

In selecting the values for the conductance of air space in framewalls, the question arises as to what insulating value should be given to the studding which passed through this air space. From a practical standpoint, this would naturally be neglected, but for the purpose of more accurate checks, this effect should at least be considered. The thermal resistance of the studding may be easily determined and the average resistance for air space and studding might be calculated on the basis of parallel circuits of heat flow. The results thus obtained would only be true, in case the studding did not effect the conductivity of the air space. If we analyze the condition, it is evident that the greater part of the heat transferred across the air space is by the convected air currents, the air taking the heat from the hot surface transferring it over to the cold surface. The effect of the surface of the studs which pass through the air space is to increase the hot and cold surfaces in contact with the air, or in other words, some of the heat transferred across the space is picked up from the surface of the studding next to the hot side and given back to the surface of the studding next to the cold side of the space. The effect of the studding on increasing the heat transfer in this manner depends upon their conductivity, and upon the ratio of the area of the exposed surfaces of the studding to the width of the air space. It is evident that the exact relation here would be very difficult to determine, but that the effect would be to increase the

Table 3—Surface Coefficients Used for Calculating the Overall Transmission Coefficients of Walls

| Surface | Mean Temperature | $f_i$ | $f_o$ |
|---|---|---|---|
| Plaster | 77 | 1.8 | ..... |
| Sheet Rock | 75 | 1.7 | ..... |
| Stucco | 5 | ..... | 1.5 |
| Siding | 5 | ..... | 1.6 |

TABLE 4—DESCRIPTION OF WALLS TESTED AND CALCULATED

| Wall No. | Type of Wall | Inside Construction | Outside Construction | Insulation | Air Space |
|---|---|---|---|---|---|
| 8 | Frame | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | None | One 3½" air space. |
| 8A | Frame<br>Same as 8<br>(Note 1) | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | None | One 3½" air space |
| 8B | Frame<br>(Notes 2, 3) | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing building paper.<br>4" pine lap siding | Two thicknesses of insulation K applied between studding to divide air space into three parts | Two 1⅛" air spaces.<br>One ⅜" air space. |
| 10 | Frame | ⅜" wood lath<br>⅜" plaster | Insulating board B<br>Building paper<br>4" pine lap siding | None | One 3½" air space. |
| 11 | Frame | Insulating board B<br>⅜" plaster | Insulating board B<br>Building paper<br>4" pine lap siding | None | One 3½" air space. |
| 12 | Frame<br>(Note 2) | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | Insulation C flanged midway in air space between studding | Two 1⅜" air spaces. |
| 15 | Frame<br>(Notes 2, 4) | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | Insulation E flanged midway in air space between studding | Two 1½" air spaces. |
| 16 | Frame | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | Insulation C nailed on studding under sheathing | One 3½" air space. |
| 19 | Frame | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | Insulation A placed back against sheathing | One 3" air space. |
| 23 | Frame | Insulating board G nailed to studding | Insulating board G nailed to studding | None | One 3½" air space. |
| 26 | Frame<br>(Note 5) | Insulation G<br>⅜" plaster | Insulation G, building paper<br>4" pine lap siding | None | One 3½" air space. |
| 28 | Frame<br>(Note 2) | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | Two thicknesses insulation H spaced between studding to divide air space into three equal parts | Three 1.08" air spaces. |
| 33 | Frame | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | 1.11" of insulation J applied between studding directly to sheathing | One 2.4" air space. |
| 34 | Frame<br>(Notes 2, 6) | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | Insulation B, with heavy craft paper on cold side, placed midway between studding | Two 1½" air spaces. |
| 36 | Frame<br>(Note 2) | ⅜" gypsum<br>Papered on each side | ¾" fir sheathing building paper.<br>4" pine lap siding | Insulation A, covered on both sides with light craft paper | Two 1⅜" air spaces. |
| 37 | Frame with brick veneer.<br>(Note 7) | ⅜" wood lath<br>⅜" plaster | Face brick | Insulation J, 1.11" thick, applied between studding directly to sheathing | One ¾" air space between brick and paper in addition to air space of wall 33. |
| 42 | 8" brick<br>(Note 8) | ⅜" wood lath<br>⅜" plaster | 4" face brick backed with 4" common brick | Insulation J, .814" thick, applied to inner surface of brick between 1⅝" furring strips | One .5" air space between insulation and lath.<br>One .6" air space between inner and outer courses of brick. |
| 53D | Frame<br>(Note 2) | ⅜" gypsum<br>Papered on each side | ¾" fir sheathing, building paper.<br>4" pine lap siding | Insulation C flanged between studding | Two 1⅜" air spaces. |
| 53F | Frame | ⅜" wood lath<br>⅜" plaster | ¾" fir sheathing, building paper.<br>4" pine lap siding | None | One 3½" air space. |

Notes for Table 4:

(Note 1) Wall 8A Test area of wall was blocked off to prevent convection currents.

(Note 2) 40 deg. was taken as the average mean temperature for the air spaces.

(Note 3) Wall 8B A paper board header was used in air space at three-foot intervals.

(Note 4) Wall 15 The application of the insulating material causes air spaces to be formed between the craft paper and hairfelt. These spaces cover about 65 per cent of the area and average 0.6 in. in thickness.

(Note 5) Wall 26 Wall 26 was made up by adding surface finishes to wall 23.

(Note 6) Wall 34 Air space between insulating board and craft paper averaged 0.2 in.

(Note 7) Wall 37 The siding was removed from Wall 33. A 4-in. face brick was then added leaving a ¾-in. air space between brick and sheathing. The conductivity for the brick was taken from a test on a 4-in. clay brick wall.

(Note 8) Wall 42 The inner surface of brick was covered with two coats of waterproof cement before the insulation was applied.

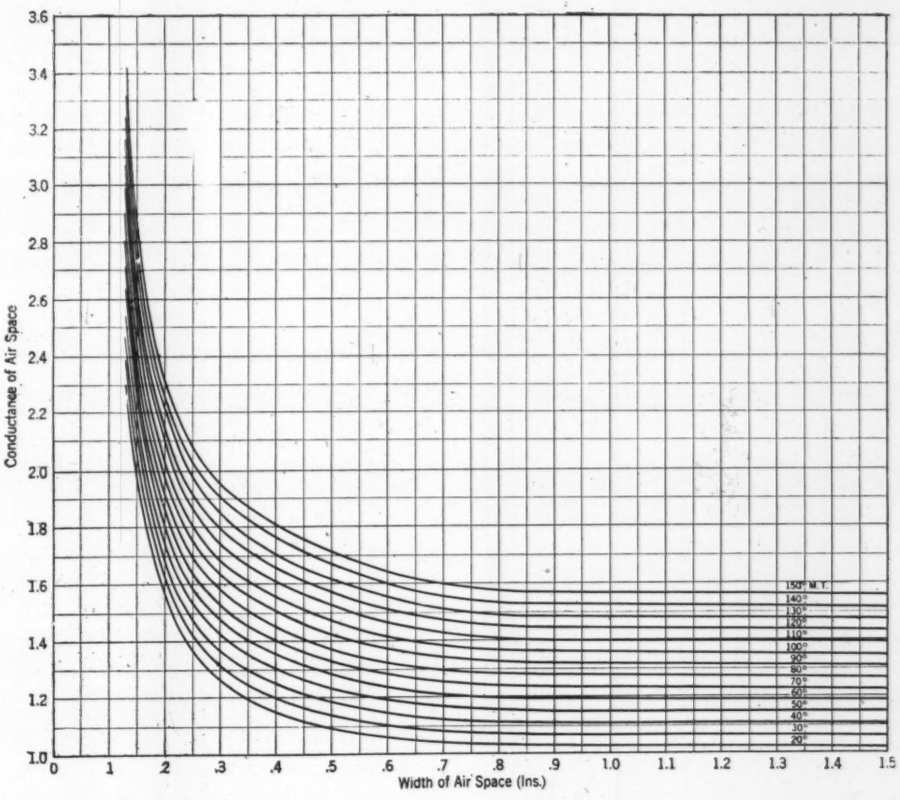



FIG. 1.—CONDUCTANCE OF AIR FOR DIFFERENT MEAN TEMPERATURES FAHRENHEIT

heat transfer across the air space and to neutralize the effect due to the additional insulating value of the studding. When it is considered that only 10 per cent of the air space area is covered by the studding, it is evident that the effect is very small, and in cases where insulation is placed in the air space between the studding, the insulating value of the air space and studding is substantially the same and any possible difference may be neglected. Tests made for the purpose of determining air space values with and without studding passing through the test area showed that there was no appreciable difference in the overall coefficients. The effect of the studding was, therefore, omitted in all calculations for the overall coefficients.

An analysis of the results given in Table 6 shows that there is a very close agreement between test and calculated results, the maximum variation being 3.59 per cent. For wall 8B which shows the greatest variation, the insulation was held between the studding by friction and there was a possibility of a small amount of infiltration of air past the joints which would increase the test results. Wall 12 was insulated with a felted material between two layers of paper in which there was some uncertainty as to the exact thickness of the insulation. Some variation may also be accounted for by the different characteristics of walls built after the same specifications. For instance, several of the walls have been duplicated from different lots of material. The average variation in test results has been found to be 2 per cent with a maximum of 5 per cent. The sheathing of the wall which showed a 5 per cent variation was found to be about 3/32 in.

TABLE 5—COEFFICIENTS USED FOR CALCULATING THE OVERALL TRANSMISSION CONSTANTS OF WALLS

| Wall No. | $f_1$ | Mean Temp. Deg. Fahr. | $f_0$ | Mean Temp. Deg. Fahr. | Conductance Inner Construction | Mean Temp. Deg. Fahr. | Conductance Outer Construction | Mean Temp. Deg. Fahr. | Conductivity Insulation | Mean Temp. Deg. Fahr. | Conductance of Air Space | Mean Temp. Deg. Fahr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | None | | 1.14 | 48.0 |
| 8A | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | None | | 1.14 | 48.0 |
| 8B | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.374 | 40.0 | (3) 1.10 | 40.0 |
| 10 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.354 | 26.0 | 0.315 | 30.0 | 1.14 | 48.0 |
| 11 | 1.8 | 77 | 1.6 | 5.0 | .587 | 63 | 0.354 | 26.0 | 0.330 Inside | 62.0 | 1.10 | 40.0 |
| | | | | | | | | | 0.315 Outside | 30.0 | | |
| 12 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.253 | 40.0 | (2) 1.10 | 40.0 |
| 15 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.238 | 40.0 | (2) 1.10 | 40.0 |
| 16 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.250 | 35.0 | 1.14 | 48.0 |
| 19 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.297 | 35.0 | 1.14 | 48.0 |
| 23 | 1.7 | 77 | 1.6 | 5.0 | .753 | 62 | 0.723 | 22.0 | 0.362 Inside | 62.0 | 1.10 | 40.0 |
| | | | | | | | | | 0.340 Outside | 22.0 | | |
| 26 | 1.8 | 77 | 1.6 | 5.0 | .696 | 63 | 0.392 | 26.0 | 0.362 Inside | 62.0 | 1.10 | 40.0 |
| | | | | | | | | | 0.342 Outside | 30.0 | | |
| 28 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.470 | 40.0 | (3) 1.10 | 40.0 |
| 33 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.272 | 35.0 | 1.14 | 48.0 |
| 34 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | 0.318 | 40.0 | (2) 1.10 | 40.0 |
| | | | | | | | | | | | (1) 1.62 | 37.0 |
| 36 | 1.7 | 75 | 1.6 | 5.0 | 3.30 | 70 | 0.50 | 20.0 | 0.300 | 40.0 | (2) 1.10 | 40.0 |
| 37 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | (4″ brick 1.24) | 19.0 | See wall 33 | | 1.14 | 48.0 |
| | | | | | | | | | | | 1.04 | 20.0 |
| 42 | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | (4″ brick 1.24) | 19.0 | 0.283 | 60.0 | (1) 1.32 | 68.0 |
| | | | | | | | | | | | (1) 1.10 | 30.0 |
| 53D | 1.7 | 75 | 1.6 | 5.0 | 3.30 | 70 | 0.50 | 20.0 | 0.253 | 40.0 | (2) 1.10 | 40.0 |
| 53F | 1.8 | 77 | 1.6 | 5.0 | 2.50 | 70 | 0.50 | 20.0 | None | | 1.14 | 48.0 |

thicker than that on the walls used for comparison. Such variations must be expected in any type of construction.

The results likewise show that accurate results cannot be expected by analytical methods, unless due regard is given to the selection of the individual constants which enter into these calculations. The values of the individual materials are effected by several variables and their selection must be governed by the conditions under which the materials are used in the wall.

TABLE 6—RELATION BETWEEN CALCULATED AND TEST RESULTS

| Wall No. | Calculated Value of *U* At 40 Deg. Mean Temp. | Hot Box Value of *U* At 40 Deg. Mean Temp. | Percent Variation Based on Test Results |
|---|---|---|---|
| 8 | 0.224 | 0.226 | 0.88 |
| 8A | 0.224 | 0.225 | 0.45 |
| 8B | 0.134 | 0.139 | 3.59 |
| 10 | 0.189 | 0.186 | 1.61 |
| 11 | 0.151 | 0.153 | 1.31 |
| 12 | 0.119 | 0.115 | 3.48 |
| 15 | 0.134 | 0.134 | 0.0 |
| 16 | 0.144 | 0.141 | 2.13 |
| 19 | 0.155 | 0.155 | 0.0 |
| 23 | 0.207 | 0.212 | 2.36 |
| 26 | 0.165 | 0.168 | 1.79 |
| 28 | 0.146 | 0.142 | 2.82 |
| 33 | 0.117 | 0.116 | 0.86 |
| 34 | 0.131 | 0.129 | 1.55 |
| 36 | 0.133 | 0.130 | 2.31 |
| 37 | 0.103 | 0.106 | 2.83 |
| 42 | 0.136 | 0.137 | 0.73 |
| 53D | 0.120 | 0.120 | 0.0 |
| 53F | 0.224 | 0.217 | 3.22 |

For walls in which materials are impervious to the flow of air and are of definite thickness and location, the calculations are comparatively simple. For conditions in which the materials are porous or where the thickness in the wall is indeterminate, with indefinite air spaces and possible communication between the air spaces, the calculated results are less accurate and more apt to be misleading.

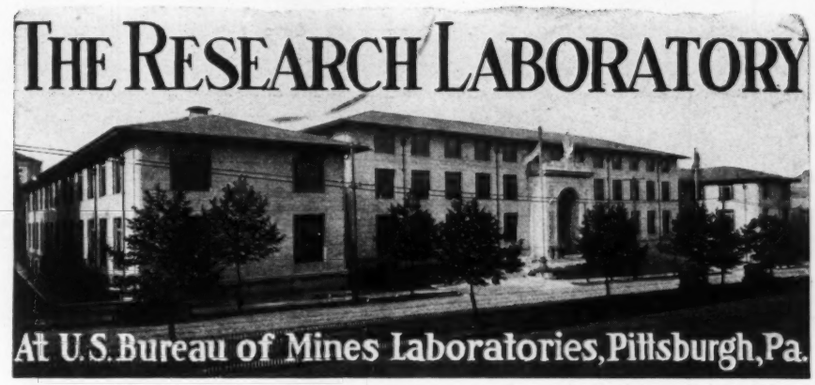
In order to determine the effect of some of these doubtful conditions, a wall was built with a removable inner surface. This wall was tested without insulation and with different materials applied between the studding. The results of these tests are given in Table 7. The original wall without insulation, or 53A, gave results by test and by calculation which check very closely. For wall 53B with a porous material placed so as to divide the air space into two equal parts, the test results were 14.7 per cent higher than the calculated results. This was due to the infiltration of air through the insulating material used. For wall 53D with an impervious insulating material dividing the air space, the calculated results checked with the test results. These results show the effect of excessive air infiltration between air spaces.

When the insulating materials of walls 53B and 53D were cut off 1 in. at the top and bottom allowing the air to circulate around the insulation, the test showed for wall 53B an increase of 33 per cent, and for wall 53E an increase of 53 per cent over the calculated results for the same walls with the insulation sealed at the top and bottom. These tests indicate very definitely that the installation of insulating materials is a very important factor. For commercial insulating materials which are used to divide the air space between the studding, the most important factor to be considered is the sealing of these materials at the top and bottom of the air space in order to prevent a direct transfer of heat around the material by air currents.

The results of this investigation show conclusively that reliable overall coefficients may be obtained by the hot-box method of testing or by calculations, providing the proper coefficients are available. In practice the variation to be expected in the construction of walls will give a much wider range of difference between calculated results and actual results than has been shown by these tests. This is to be expected in any type of construction, but a large part of the variation may be eliminated by reasonable care in construction and application of the insulating materials.

TABLE 7—TESTS SHOWING IMPORTANCE OF CONSIDERING POROSITY AND APPLICATION OF INSULATION WHEN CALCULATING HEAT TRANSMISSION CONSTANT OF A WALL

| Wall. No. | Type | Inside Construction | Outside Construction | Special Insulation | Hot Box Coeff. of Heat Trans. *U* at 40 Deg. Mean Temp. | Calcul. Coeff. of Heat Trans. *U* at 40 Deg. Mean Temp. |
|---|---|---|---|---|---|---|
| 53A | Frame | ⅜″ gypsum Papered on each side. | ¾″ fir sheathing, building paper. 4″ pine lap siding. | None. | 0.220 | 0.228 |
| 53B | Frame | ⅜″ gypsum Papered on each side. | ¾″ fir sheathing, building paper. 4″ pine lap siding. | A porous material placed midway in air space between studding. | 0.154 | 0.133 |
| 53C | Frame | ⅜″ gypsum Papered on each side. | ¾″ fir sheathing, building paper. 4″ pine lap siding. | Same as 53-B with 1″ of material removed from top and bottom of wall section between studding. | 0.177 | 0.133 |
| 53D | Frame | ⅜″ gypsum Papered on each side. | ¾″ fir sheathing, building paper. 4″ pine lap siding. | An impervious material placed midway in air space between studding. | .120 | .120 |
| 53E | Frame | ⅜″ gypsum Papered on each side. | ¾″ fir sheathing, building paper. 4″ pine lap siding. | Same as 53D with 1″ of material removed from top and bottom of wall section between studding. | .184 | .120 |




CO-OPERATIVE WORK BY A. S. H. V. E. LABORATORY AND THE
U. S. BUREAU OF MINES EXPERIMENT STATION, PITTSBURGH, PA.

# Capacity of Radiator Supply Branches For One and Two-Pipe Systems

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*MEMBERS*

A STUDY of the capacity of pipe for various parts of a steam heating system has been under way at the Research Laboratory since 1922, and these data result from a co-operative study by the Society and the Heating and Ventilating Department of the Carnegie Institute of Technology. A number of reports bearing on various phases of the subject have been published from time to time including a complete and final report[4] on the subject of capacity of upfeed steam heating risers for one and two-pipe steam heating systems.

This paper deals with the results of a study of capacity of radiator supply branches for one and two-pipe systems and gives final results on this phase of the study.

There are a number of variable factors entering into the capacity of radiator supply branches all of which must be taken into account in making an analysis of the subject. A typical radiator supply branch from a supply riser is shown in Fig. 1. Its capacity is affected by the pipe fittings, *C* to *D* and *E* to *G*, by the capacity of the vertical section of the branch *FG*, by the valve *G*, and by the pitch of the main section of the branch *DE*. The steam carrying capacity of the branch further depends upon whether the condensation from the radiator returns through this branch (one-pipe system) or through a separate return (two-pipe system). In order to have a clear understanding of the operation of such a branch it was necessary to make an independent study of each of these factors.

Fig. 1 is the laboratory set-up on which the study of supply branches to radiator was made. Steam was taken from the 8-in. main, through the 6-in. branch to the 4-in. supply riser *AB*. The radiator supply branch *CH* on which the study was made supplied steam to a cast iron radiator or water cooled condenser *I*, located on a movable platform so that the length and pitch of *DE* could be changed.

When the branch was operated as a one-pipe system, *J* was closed off and the condensate returned through the radiator supply branch and riser and collected and weighed at *L*. When operating as a two-pipe system *J* was opened and the condensate from the radiator was returned through the return riser and weighed at *K*.

In order to observe any effect which steam passing on up the riser beyond *C* had on the operation of the branch and radiator under study, a second radiator or condenser, *M*, was supplied steam during a part of the study. It was soon found that steam passing on up the riser beyond *C* did not affect the operation of the branch *CH* unless the riser *AC* was loaded beyond the maximum capacity recommended for use in an earlier laboratory study[5]. After this fact was established the riser was cut beyond *C* and capped.

The condensation in the system other than the branch and radiator studied was determined for all operating conditions. When the branch was operating as a one-pipe system the total condensation collected at *L* was reduced by this amount in order to determine the steam and condensation carried by the branch.

Steam pressures were observed in the main, riser, and radiator and a water column was provided to give the level of any water which might be held up in radiator.

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[4] Capacity of Up-Feed Steam Heating Risers for One and Two-Pipe Systems—by F. C. Houghten, and M. E. O'Connell, Trans. AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, 1927, Vol. 33.

For presentation at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Ontario, June, 1929.

[5] Capacity of Up-Feed Steam Heating Risers for One and Two-Pipe Systems, by F. C. Houghten and M. E. O'Connell, TRANSACTIONS AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, 1927, Vol. 33.

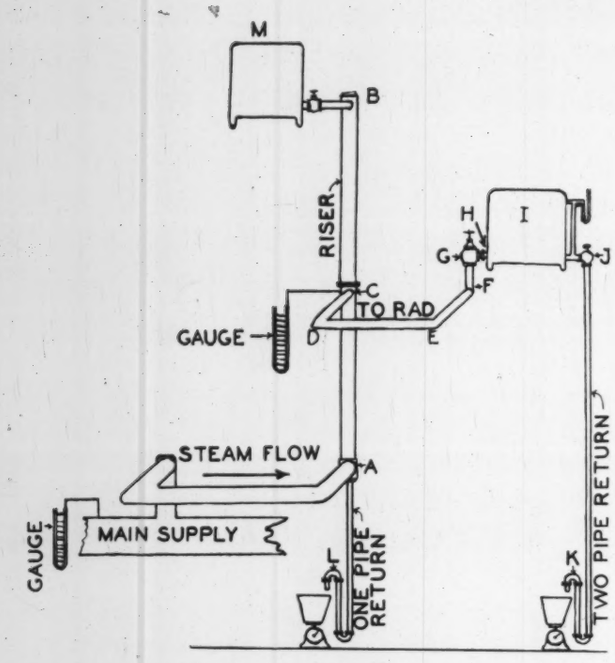



FIG. 1. LABORATORY SET-UP FOR STUDYING RADIATOR BRANCHES

## Results

In attacking the problem the relation between steam pressure in the main or the riser and the capacity of the branch as a whole, for any given set of conditions, considering the variables mentioned, was determined and the results plotted in the form of a curve such as *A*, *B*, or *C*, Figs. 2 or 3. These curves are similar to curves showing this relationship in other laboratory publications[6]. In further analysis of the results the maximum capacity, or the highest point *x*, reached on any particular curve for a given branch was taken as the capacity of that branch. Data for such a curve were collected and the curve plotted in order to obtain this maximum point for each of the many variable conditions on which information was desired.

Point *x* on Curve *C*, Fig. 2, is the maximum capacity of a 1¼-in. branch similar to Fig. 1 in which all fittings, pipe, and angle valve were of 1¼-in. nominal size and with a pitch in section *DE* of 3.5 in 10 ft. Point *x* on curve *C*, Fig. 3 gives the maximum capacity of the same branch with a pitch of 1-in. in 10 ft. Curve *C*, Fig. 4, shows the variation in maximum capacity of this branch with pitch.

The valve used in the branch giving the results shown by Curve *C* Figs. 2, 3, and 4 was a standard 1¼-in. angle valve. It was found that this valve and in fact, most valves studied, had a seat opening just 1¼-in. in diameter instead of 1.38 in. in diameter which is the actual internal diameter of nominal 1¼-in. pipe. Another series of data was collected giving curves *B*, Figs. 2, 3, and 4 in which the radiator connection was the same as that giving curves *C*, excepting that the 1¼-in. valve was replaced by a 1¼-in. ell. It was later shown that the same increase in capacity could be had by drilling out the seat of the valve to a diameter equal to that of the same nominal size pipe or by replacing the valve by one of the next larger size.

The data given in Curves *A*, Figs. 2, 3, and 4 were obtained on a similar branch with 1½-in. fittings replacing the 1¼-in. fittings at *CD* and *EG*, Fig. 1. It was further shown that replacing the fittings at either *CD* or *EG* alone with the larger size gave the same curves as *B*. Hence it is clear that the capacity shown by *C*, *B*, and *A* in Figs. 2, 3, and 4 are, respectively, the limiting capacities of the horizontal branch alone, the fittings and the valve, of the same nominal size.

Comparison of curves *C* and *B*, Fig. 4 shows that the maximum capacity of the valve was equal to that of the branch with a pitch of 1.58 in. in 10 ft. For greater pitches of the main section of the branch the valve restricted the flow, whereas for smaller pitches the section *DE* of the branch limited the flow.

[6] a. Capacities of Steam Heating Mains as Affected by Critical Velocities of steam and Condensate Mixtures—by F. C. Houghten and Louis Ebin, TRANS. AMER. SOC. HEAT. AND VENT. ENGRS. 1922. Vol. 28, p. 289.

b. Capacities of Steam Heating Risers As Affected by Critical Velocity of Steam and Condensate Mixtures—by F. C. Houghten and Louis Ebin, TRANS. AMER. SOC. HEAT. AND VENT. ENGRS. 1923. Vol. 29, p. 109.

c. Capacity of Up-feed Steam Heating Risers for One and Two-pipe Systems—by F. C. Houghten and M. E. O'Connell, TRANS. AMER. SOC. HEAT. AND VENT. ENGRS. 1927, Vol. 33.

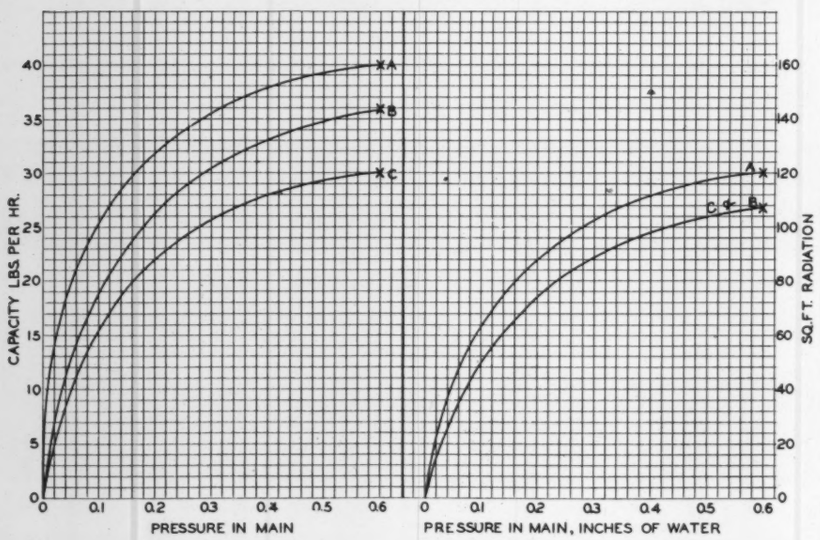



FIG. 2. (LEFT) 1¼-IN. ONE-PIPE BRANCH. 3½-IN. PITCH IN 10 FT. Curve A, no valve, 1½-in. fittings, 1¼-in. pipe. Curve B, no valve, fittings and pipe, 1¼-in. Nominal size. Curve C, valve, fittings and pipe, 1¼-in., nominal size.

FIG. 3. (RIGHT) 1¼-IN. ONE-PIPE BRANCH. 1-IN. PITCH IN 10 FT. Curve A, no valve, 1½-in. fittings, 1¼-in. pipe. Curve B, no valve, fittings and pipe, 1¼-in., nominal size. Curve C, valve, fittings and pipe, 1¼-in., nominal size.

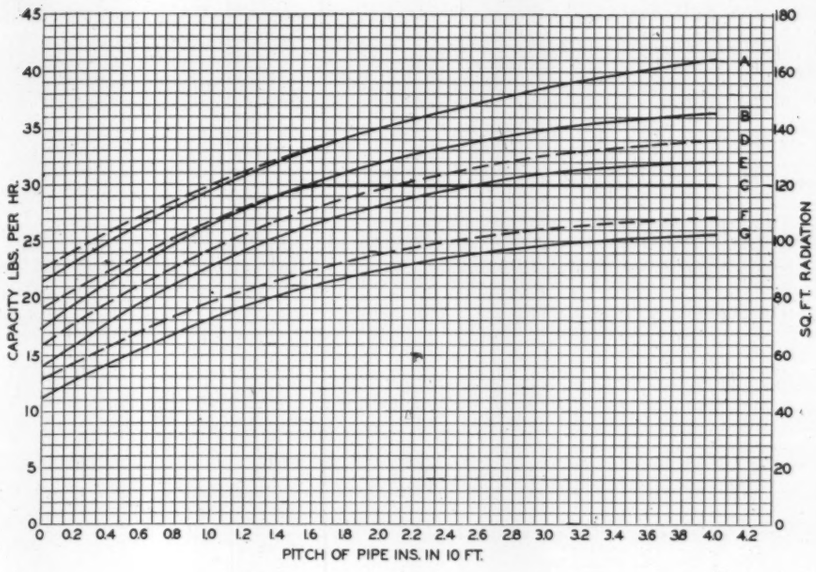



FIG. 4. ONE-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT. Curve A, no valve, 1½-in. fittings, 1¼-in. pipe. Curve B, no valve, fittings and pipe 1¼-in., nominal size. Curve C, valve, fittings and pipe 1¼-in., nominal size. Curves A, B, and C, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G 80 per cent of maximum capacity with no noise.

The data just referred to are all for a 10 ft. branch with one-pipe connection (that is for a branch where the condensation from the radiator returns through the supply branch) and they were collected on a set-up where a water-cooled condenser was used to condense the steam, rather than a radiator. With this set-up small noises due to overloaded branches could not be detected easily because of the noise of the water flowing through the condenser and also due to the fact that the small steam condensing space of the condenser did not seem to give the same reverberation to the sound as was experienced with a standard cast iron radiator. The curves *D* and *E*, Fig. 4 give the maximum capacities obtainable with steam condensed in a cast iron column radiator instead of the water-cooled condenser and with the system operating without audible sound. Curves *A*, *B*, *C*, *D*, and *E*, Fig. 5, give data for a two-pipe radiator connection (that is with the condensation returning from the radiator through a separate return branch and riser, similar to that shown in Fig. 4 for the one-pipe branch. For this condition it will be noted that there is no difference between maximum capacity obtainable with a valve of the same nominal diameter as the pipe (Curves *B* and *C*). This is accounted for by the fact that in the two-pipe connection of the type shown in Fig. 1, no condensation returns through the valve. All the steam that condenses beyond the valve returns through the radiator while that condensing below the valve returns through the supply branch and riser. In this system a valve with a small seat will not result in noise unless it is purely a hissing sound due to the velocity of steam through the valve. A small valve, however, will require a higher steam pressure for the same capacity.

The effect of length of a branch on its capacity was investigated by studying branches 5 ft. and 10 ft. in length. The solid line curves Figs. 2, 3, 4 and 5 give the capacities of the 10 ft. branches, while the capacities of the 5 ft. branches are given by the broken line curves.

It will be noted that for small pitches the effect of the length of the branch is much more pronounced when the condenser was used or when the sound was not the limiting factor. This may be explained by the fact that part of the head producing flow in the horizontal pipe may be due to piling up of water at the end from

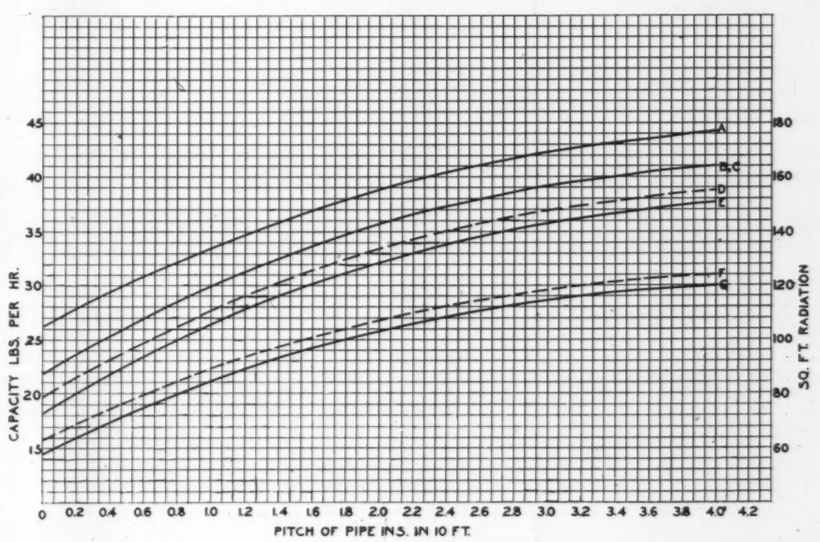



FIG. 5. TWO-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT. Curve A, no valve, 1½-in. fittings, 1¼-in. pipe. Curve B, no valve, fittings and pipe 1¼-in., nominal size. Curve C, valve, fittings, and pipe 1¼-in., nominal size. Curves A, B, and C, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G 80 per cent of maximum capacities with no noise.

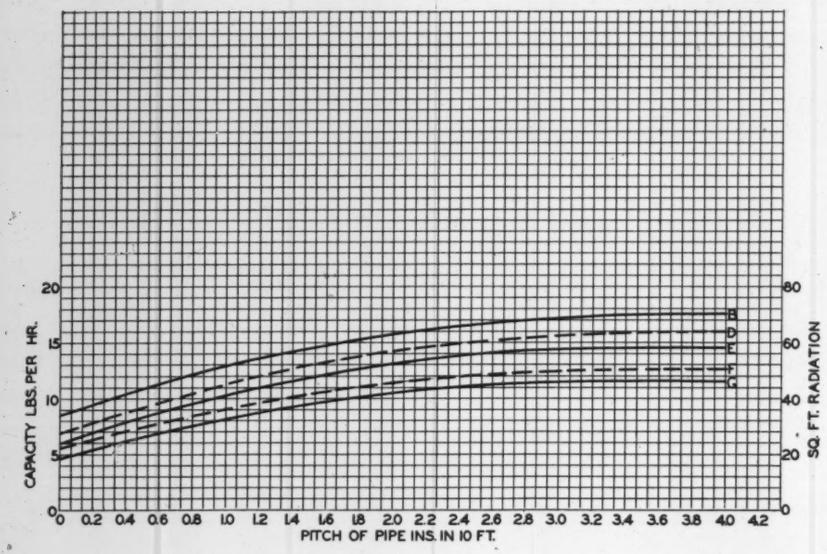



FIG. 6. ONE-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT. Curve B, no valve, fittings and pipe 1-in., nominal size, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G, 80 per cent of maximum capacities with no noise.

which it is flowing so that the actual diameter of the pipe may be considered to some extent as producing flow of condensate counter to the steam. A perfectly level pipe or in fact one with a small reverse pitch will allow condensate to return, but at a reduced rate. The effect which the diameter of the pipe has on producing flow is a function of the length of the pipe. Hence it will be seen that the possible head varies inversely with the length of the pipe and directly with its diameter. This, no doubt, accounts for the fact that the difference in capacity of the 5 and 10 ft. length of pipe is more pronounced in the larger branches. It also accounts for the fact that the effect of the length of the branch on its capacity decreases rapidly as the actual pitch of the pipe increases.

TABLE 1. CAPACITY OF RADIATOR SUPPLY BRANCHES ONE-PIPE SYSTEM

| Pipe Size | Capacity in Sq. Ft. of Equivalent Radiation | | | |
|---|---|---|---|---|
| | Based on Curves *F* and *G* and pitch of 0.6 in. in 10 ft. | | Based on Guide 1929 Tables 8 and 11, Pitch at least ½ in. in 10 ft. | |
| | 5-ft. Branch | 10-ft. Branch | Shorter than 8-ft. Branch | Longer than 8-ft. Branch |
| *A* | *B* | *C* | *D* | *E* |
| 1 in. | 31 | 28 | 20 | ..... |
| 1¼ in. | 68 | 62 | 55 | 20 |
| 1½ in. | 102 | 93 | 81 | 55 |
| 2 in. | 189 | 169 | 165 | 81 |

Similar data to that given in Figs. 4 and 5 for the 1¼-in. one and two-pipe branches are given in Figs. 6 and 7, 8 and 9, and 10 and 11, for 1-in., 1½-in. and 2-in., one and two-pipe branches respectively. Fig. 12 gives the maximum capacity with noise for a ¾-in. branch in a one and a two-pipe system. Data for maximum capacity with noise are given only for the ¾-in. branch. The curves, Figs. 6 to 11 give data only for the capacity of

When the steam was condensed in the radiators without noise (Curves *D* and *E*) the difference in maximum capacity of the 5 and 10 ft. lengths, without noise, was little affected by the pitch of the branch.

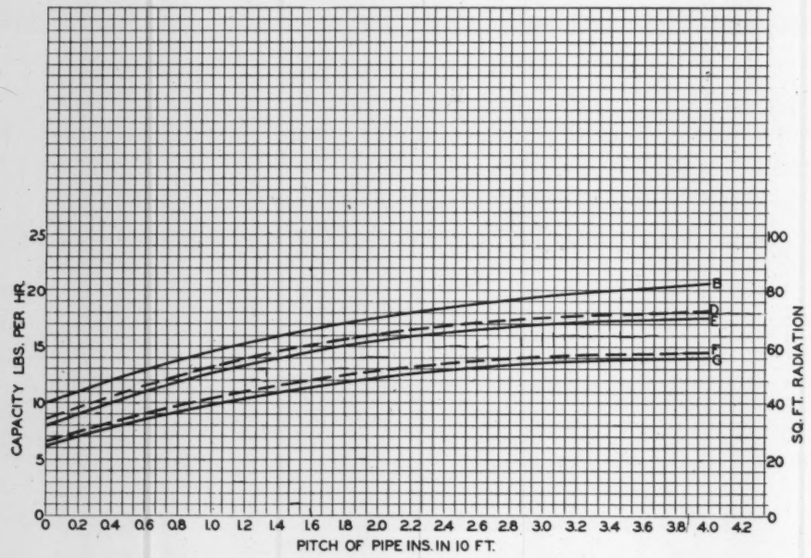



FIG. 7. TWO-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT. Curve B, no valve, fittings and pipe 1-in., nominal size, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G, 80 per cent of maximum capacities with no noise.

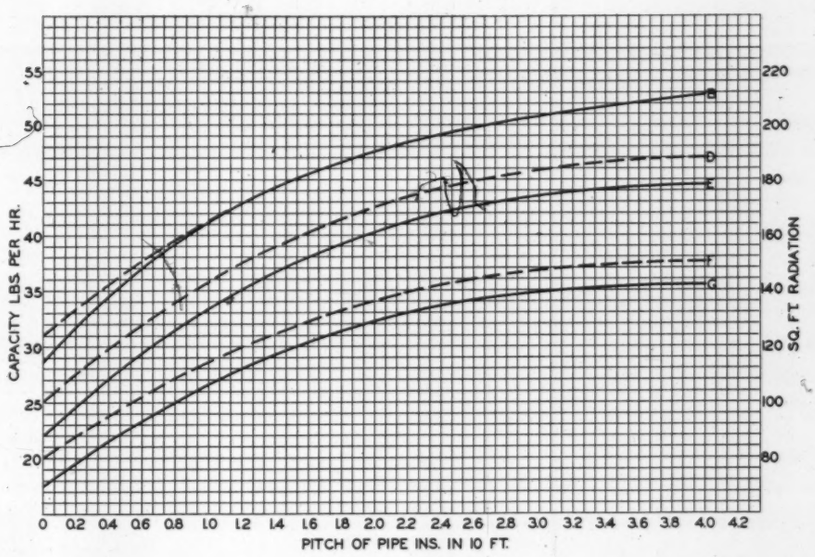



FIG. 8. ONE-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT. Curve B, no valve, fittings and pipe 1½-in., nominal size, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G, 80 per cent of maximum capacities with no noise.

the branch with fittings of the same nominal size and no valve for the reasons that larger fittings in a branch are not practicable and capacity of valves vary with design and a single figure could not be given which would be representative of all makes.

Figs. 13 and 14 show how the maximum capacity of branches without noise varies with pitch, area, and length of pipe in the one and the two-pipe systems, respectively. Figs. 15 and 16 show how the maximum allowable velocity without noise varies with pitch of branch and pipe area for 5 ft. and 10 ft. one and two-pipe branches.

### Practical Application

The purpose of the study was to make available information concerning the flow of steam and condensate in one and two-pipe radiation branches on which a practical and logical set of pipe sizing tables could be based. This information is given in the curves *A* to *E*, Figs. 4 to 11 and in Figs. 13 to 16. In making use of these values, however, it should be borne in mind that they are maximum values which could be obtained on commercial pipe under good laboratory conditions. The pipe was well reamed, was new, clean, and straight so there were no sags in the branches.

TABLE 2. CAPACITY OF RADIATOR SUPPLY BRANCHES TWO-PIPE SYSTEM

| Pipe Size | Capacity in Sq. Ft. of Equivalent Radiation | | | |
|---|---|---|---|---|
| | Based on curves *F* and *G* and pitch of 0.6 in. in 10 ft. | | Based on Guide 1929, Tables 9, 10, 12, 13, 14. Pitch at least ½ in. in 10 ft. | |
| | 5-ft. Branch | 10-ft. Branch | Shorter than 8 ft. | Longer than 8 ft. |
| *A* | *B* | *C* | *D* | *E* |
| 1 in. | 36 | 34 | 26 | ..... |
| 1¼ in. | 79 | 75 | 58 | 26 |
| 1½ in. | 117 | 108 | 95 | 58 |
| 2 in. | 209 | 191 | 195 | 95 |

These conditions will not always be had in practice and some allowance must be made therefore. This allowance will be in the nature of a factor of safety. A

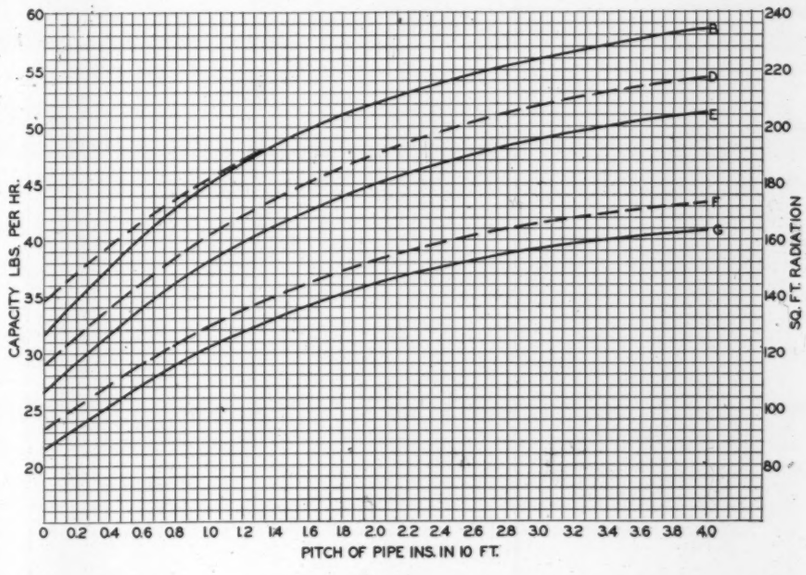



FIG. 9. TWO-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT. Curve B, no valve, fittings and pipe 1¼-in. size, maximum capacities with noise. Curves D and E maximum capacities without noise. Curves F and G, 80 per cent of maximum capacities with no noise.

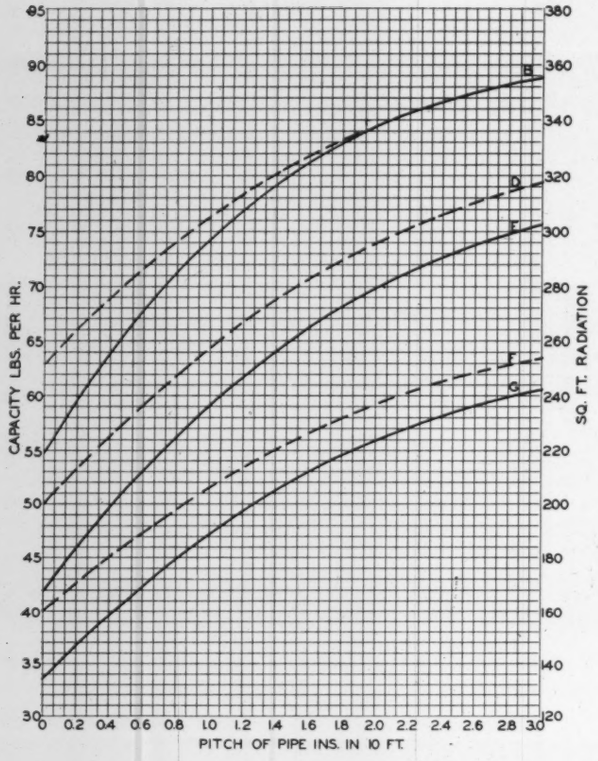



FIG. 10. ONE-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT.

Curve B, no valve, fittings and pipe, 2-in., nominal size, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G, 80 per cent of maximum capacities with no noise.

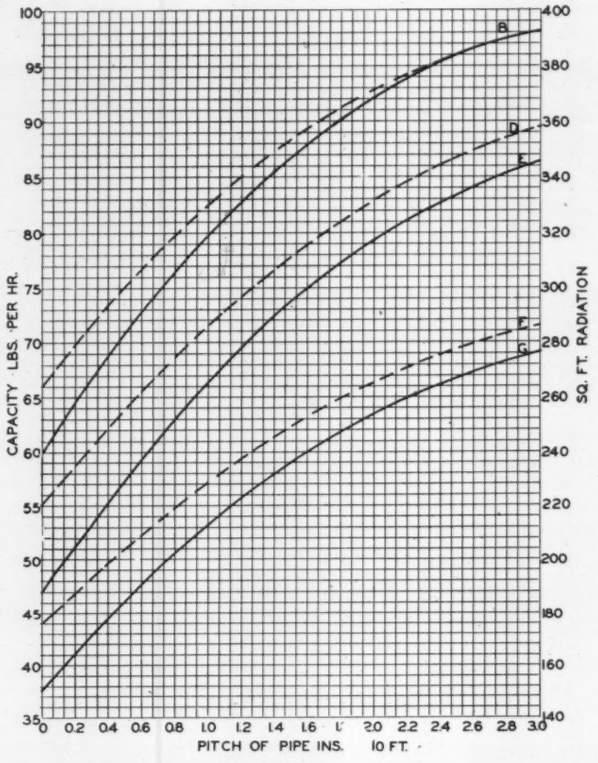



FIG. 11. TWO-PIPE BRANCH. SOLID LINE 10 FT. BROKEN LINE 5 FT.

Curve B, no valve, fittings and pipe, 2-in., nominal size, maximum capacities with noise. Curves D and E, maximum capacities without noise. Curves F and G, 80 per cent of maximum capacities with no noise.

factor of safety cannot be established by laboratory test alone but should also take into account other factors depending on installation and operating conditions, which factors can better be supplied from the practical experience of heating engineers.

Curves *F* and *G*, Figs. 4 to 11 inclusive, give a suggested capacity of branches of the different sizes studied based upon a factor of safety of 20 per cent. The capacities given by curves *F* and *G* are 80 per cent of those given by curves *D* and *E*.

It should be pointed out that values given in the curves are maximum capacities or maximum capacities less a factor of safety as specified. No allowance is made for heating-up load and condensation in either bare or covered pipe. Since these factors vary with other conditions they should be considered as factors in calculating the maximum demand for steam.

Tables 1 and 2 give capacities of one and two pipe branches, ranging from 1 in. to 2 in. in size as taken

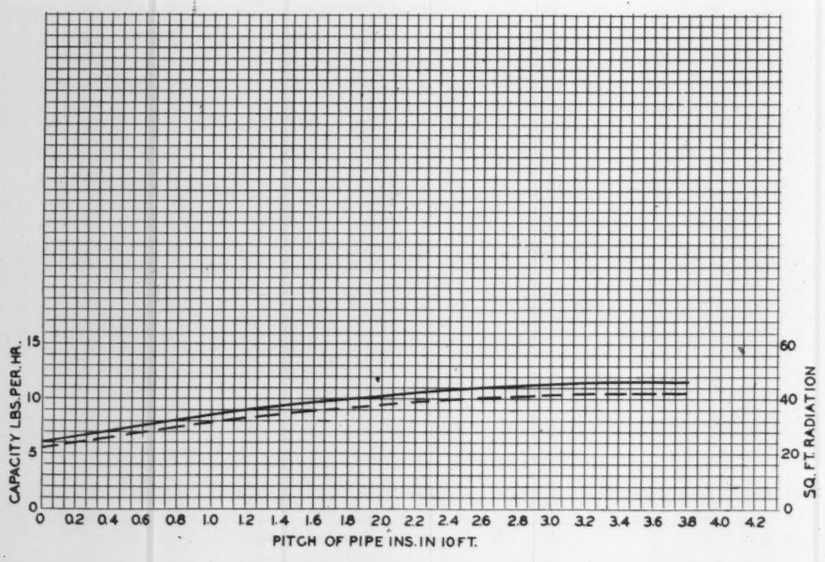



FIG. 12. ONE AND TWO-PIPE BRANCH.

Solid line 5 ft. Two-pipe, no valve, fitting and pipe ¾-in. nominal size. Broken line 5 ft. one-pipe, no valve, fitting and pipe ¾-in. nominal size. Both curves are for maximum capacity with noise.

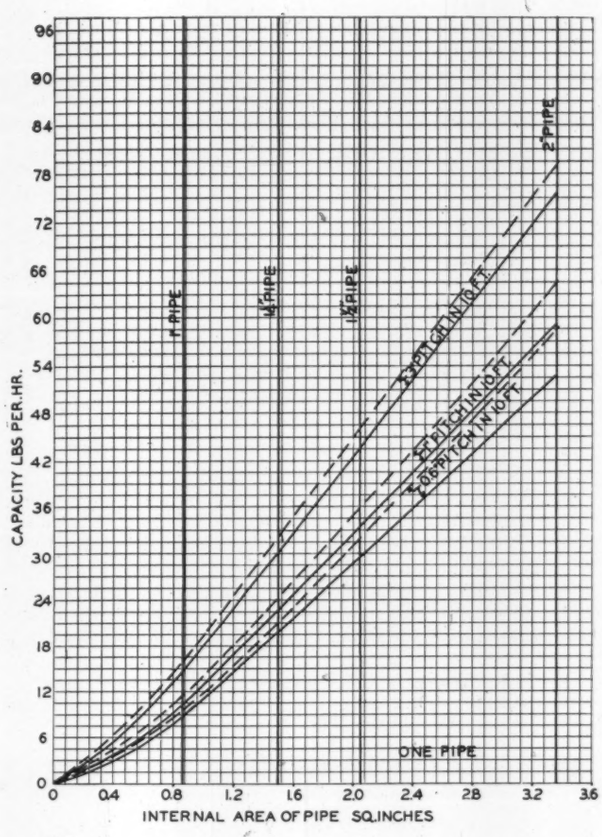



FIG. 13. VARIATION OF CAPACITY WITH PIPE AREA, LENGTH AND PITCH OF ONE-PIPE BRANCH. NO NOISE. SOLID LINE CURVES 10 FT. BROKEN LINE CURVES 5 FT.

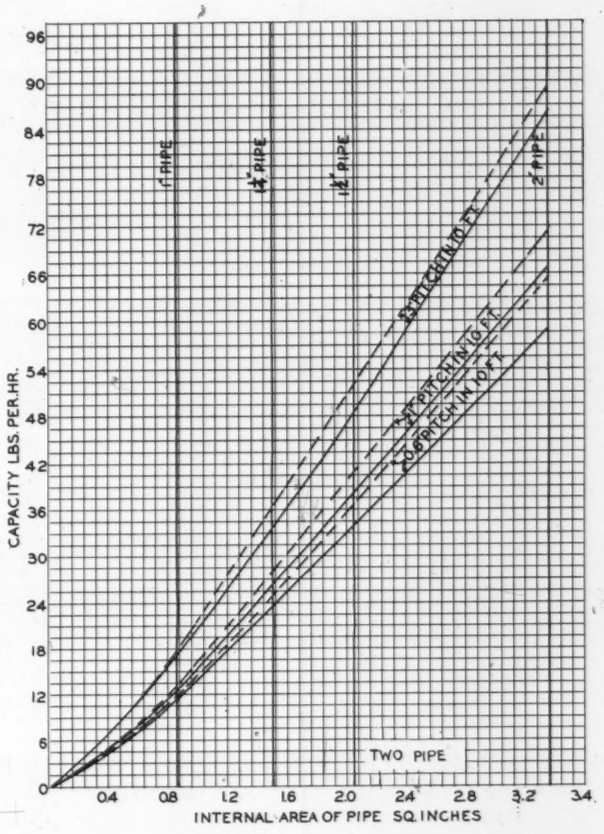



FIG. 14. VARIATION OF CAPACITY OF A TWO-PIPE BRANCH WITH PIPE AREA, LENGTH AND PITCH. NO NOISE. SOLID LINE CURVES 10 FT. BRANCHES. BROKEN LINE CURVES 5 FT. BRANCHES.

from curves *D* and *E*, Figs. 4 to 12 and from THE GUIDE 1929.

THE GUIDE tables specify that branches longer than 8 ft. should be one pipe size larger. Also that branches should have a pitch of at least ½-in. in 10 ft. Capacities in columns *B* and *C* in the two tables based upon this study are for a pitch of 0.6 in. in 10 ft. or approximately 1 in. in 16 ft.

## Summary and Conclusions

1. The investigation gives the capacities of one and two-pipe radiator supply branches without audible sound as shown in curves *D* and *E*, Figs. 4 to 11. These capacities are, however, only had when the pipe is well reamed and should be taken with a factor of safety for less perfect workmanship.

2. A series of curves *F* and *G* Figs. 4 to 11 give

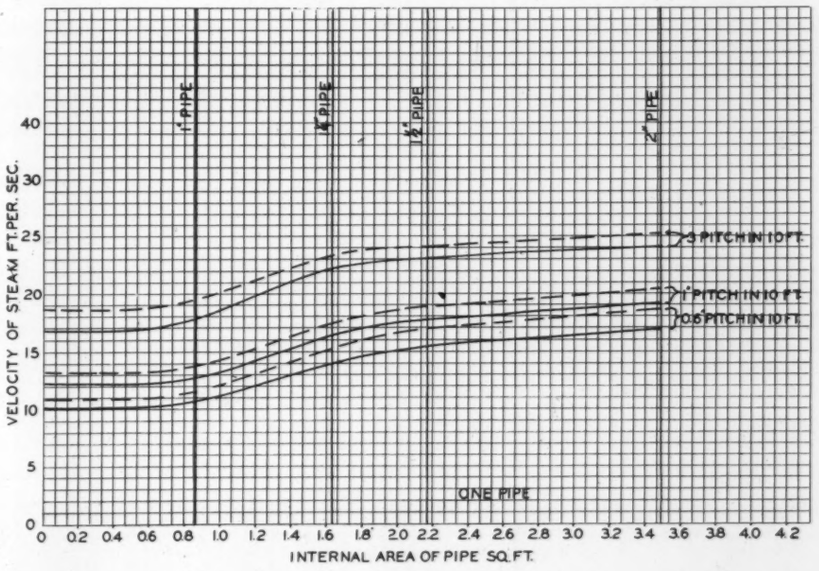



FIG. 15. VARIATION OF VELOCITY OF STEAM IN A ONE-PIPE BRANCH WITH PIPE AREA, LENGTH AND PITCH. NO NOISE. SOLID LINE CURVES 10 FT. BRANCHES. BROKEN LINE CURVES 5 FT. BRANCHES.

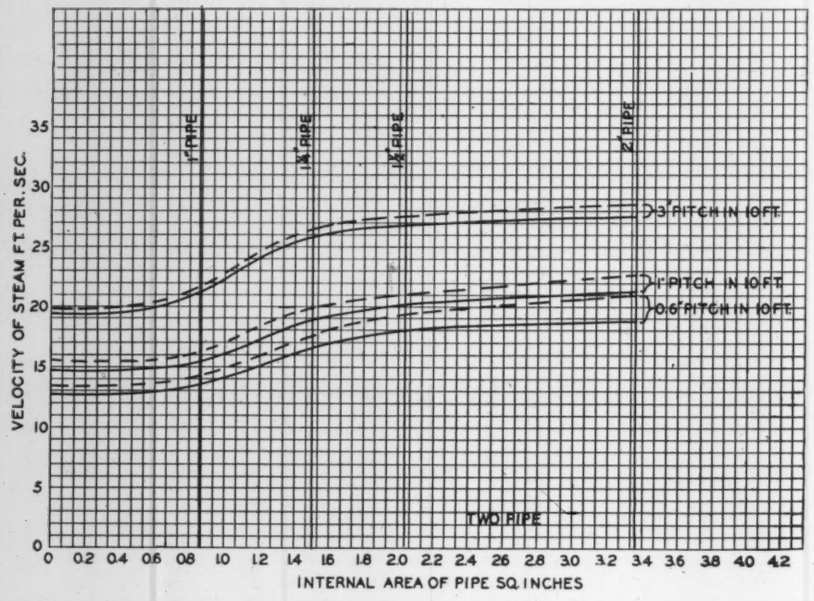



FIG. 16. VARIATION OF VELOCITY OF STEAM IN A TWO-PIPE BRANCH WITH PIPE AREA, LENGTH AND PITCH. NO NOISE. SOLID LINE CURVES 10 FT. BROKEN LINE CURVES 5 FT. BRANCHES.

capacities after a factor of safety of 20 per cent has been applied.

3. Valves found on the market frequently have port openings smaller than pipe of the same nominal pipe size. Such valves limit the capacity of radiator branches below the capacity of the pipe itself for pitches above a certain value which are, however, greater than the pitches usually allowed.

4. The capacity of a branch is greatly increased by increase in pitch.

5. There is a measurable difference between the capacity of branches 5 and 10 ft. in length which difference varies with the size of the pipe and the pitch. The larger the pipe the greater the difference in capacity with length. This difference is also more pronounced for small pitches.

# The Engineer*

Engineering is a profession so old that it has never been traced to its beginnings. When we get back to the misty boundary between the earliest accurate historical records and that vague time which we know as "pre-history" we find extraordinary monuments to the genius of engineering which have already been standing for centuries.

Nevertheless, until recently the engineer did not command the influential position he now deservedly holds in the estimation of the public.

In Progressive America, for example, the engineer who was engaged in the development of the resources of the so-called backward countries—backward in respect of their economic position—was stigmatized by our politicians as an advanced agent of unprincipled exploiters of those countries. Today, however, he is recognized as a most important missionary of civilization in opening up new territory, to contribute its mineral wealth and incidentally, its other resources to the needs of mankind.

The engineer is now universally regarded not only as a benefactor of the world at large, but as a primary factor in the betterment of conditions of the inhabitants of those countries developed by his professional skill, his indomitable courage—for courage is requisite in pioneering—and his indefatigable industry.

The engineer will, I believe, become a real "Ambassador of Good Will" when the slow consenting academic mind realizes, as it must, that beneficent deeds are more enduring and more convincing than mere gestures of professed amity.

It was the World War that established the engineer as the most important of the factors of modern civilization. Owing to the overweening ambition of so-called statesmen, the war was made possible. Inept diplomacy failed to avert it.

The engineer whose life work is devoted to creation of material prosperity and the resulting social welfare is pre-eminently an "Apostle of Peace."

Wanton destruction is to him for that reason anathema, but when the World War began it was upon the skill of the engineer that warring nations relied for their national defense; indeed, for their very existence.

Then came Peace, after the most devastating war of all time and a stricken and bewildered world—victors, vanquished and neutrals alike—sought the service of the engineer during the work of reconstruction, not only in its economic rehabilitation, but in the amelioration of the social condition of the destitute survivors of the cataclysm.

In the material development of civilization the engineer has played a most important role and in no period have his activities been more important than during the past few decades.

If we eliminate any one of the engineering elements which underlie our present civilization the entire structure collapses.

*From an address by John Hays Hammond, at dinner, given by the American Committee of the World Engineering Congress, Carlton Hotel, Washington, D. C., April 24, 1929, in honor of the Japanese Ambassador to the United States.

# Report of Committee on Heating and Ventilating Garages

IN MAY, 1928, the *National Fire Protection Association* adopted tentative regulations governing the construction and operation of bus garages prepared by its Committee on Garages, which had the following personnel: H. E. Newell, Chairman; K. W. Adkins, F. H. Alcott, E. P. Boone, K. B. Brier, E. K. Campbell, A. M. Daniels, W. K. Estep, R. H. Goodwin, Louis Harding, G. C. Hecker, W. F. Hickey, A. D. Knox, R. C. Loughead, Ray Nelson, I. Osgood, R. E. Plimpton, A. M. Schoen, H. S. Smith, John Stilwell, J. F. Templin, J. S. Trump, W. B. White and Wm. P. Yant.

An abstract from the code consisting of Sections 15 to 19, prepared jointly by a committee of the Society consisting of E. K. Campbell, chairman; W. H. Carrier, E. B. Langenberg and Thornton Lewis, appears in the following paragraphs:

**Section 15.**

(a) Heat generating plants should preferably be located in a detached building. If within the garage, the heat generating plant shall be placed in a separate room used for no other purpose and cut off horizontally and vertically from all other parts of the building by reinforced concrete walls not less than 6 inches thick, or masonry walls not less than 8 inches thick.

Openings in such walls shall be restricted to those necessary for heating pipes and ducts, which openings shall be made tight in a manner to provide for expansion and at the same time prevent air passing through the walls. Entrance to room containing the firing space shall be from the outside only.

All air entering the heat generating plant for combustion purposes shall be drawn from outside the building.

(b) Sufficient heating capacity shall be provided to maintain an inside temperature of not less than 40 deg. fahr. in the coldest weather and to maintain a temperature of not less than 35 deg. at the warm air inlet when the ventilating system is in full operation for flushing purposes.

(c) No method of heating shall be used which permits fire in the garage or in any communicating room.

(d) Motors used in connection with heating system shall be of the constant speed type. All switches and motors shall be of approved design and installed in compliance with the National Electrical Code. Polyphase motors shall be protected against single phase operation.

(e) The use of steam or hot water heating systems by either direct or indirect radiation is permitted, provided the requirements of the ventilating section of these regulations are complied with. Inside air inlets for indirect radiation shall not be higher than 2 feet above the floor.

(f) Unit heaters employing steam or hot water are permitted provided the requirements of the ventilating section of these regulations are complied with.

(g) Steam blast systems with central fan and coils together with ducts are permitted provided the requirements of the ventilating section of these regulations are complied with. The heating coils of such systems shall be separated from the firing space by masonry walls at least 8 inches thick.

(h) Warm air furnace blast systems of heating are permitted provided the requirements of the ventilating section of these regulations are complied with. The air space surrounding the furnace within the heating chamber shall be separated from the firing space by a masonry wall at least 8 inches thick or other wall of material and thickness which may be approved by the Underwriters. This wall may be formed in part by the furnace front which must be not less than ¼ inch thick, of steel or cast iron and this furnace front may be pierced only by the feed and ash pouches of the furnace, and by clean-out doors opening into the combustion space or smoke passages. Access doors through either brick wall or furnace front shall not be permitted. Warm air furnaces other than blast systems shall not be permitted.

(i) Positive recirculation of 1 cu. ft. of air per sq. ft. of floor area within the garage shall be provided in all garages having an average ceiling height of not more than 15 ft. and in all garages having greater ceiling height than 15 ft. the volume of air recirculated shall be increased in proportion to the increase in height. The return air openings in such recirculating systems shall be not more than 2 ft. above the floor.

(j) In central furnace fan plants, not less than 5 per cent of the air moved by the fan shall be taken direct from outside of the building through a duct which shall deliver the outside air to a point near the floor on which the fan rests; the duct shall be

For presentation at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Bigwin Inn, Lake-of-Bays, Ontario, Canada, June 1929.

open at all times and the air supply which is provided shall be without control.

(k) All fans used for recirculating air within the garage or exhausting air from the garage shall be of non-sparking type.

**Section 16. Ventilation of Storage Sections.**

(a) These regulations shall apply to the following garages:

1. Garages housing 35 or more motor vehicles with 3 or more walls pierced with openings.
2. Garages housing 25 or more motor vehicles with 2 walls pierced with openings.
3. Garages housing 4 or more motor vehicles and located above ground, but having less than 2 walls pierced by openings and exposed to the outside.
4. Garages housing 4 or more motor vehicles and located below the level of the ground.

(b) Natural ventilating may be employed where it is practicable to maintain open windows or other openings at all times. Such openings shall be distributed as uniformly as possible in at least two outside walls. The total area of such openings shall be equivalent to at least 5 per cent of the floor area.

(c) Where it is impracticable to operate such a system of natural ventilation, a mechanical system of ventilation shall be provided. This system may be combined with the heating system or may be an entirely separate installation.

(d) Positive provision shall be made for either the inlet of 1 cu. ft. of air per minute from out-of-doors for each square foot of floor area, or for removing the same amount and discharging it to the outside as a means of flushing the garage.

(e) For the purpose of these regulations, positive means of handling air shall be understood to mean a power-driven fan or fans of sufficient capacity to move the required volume of air.

(f) Where positive systems of exhausting air are used, the exhaust openings shall be not more than 24 inches above the floor and shall be not more than 50 ft. apart.

(g) Garages having a capacity of not less than 4 or not more than 35 cars within the scope of these regulations may consider air exhaust stacks as positive, provided they have not less than 15 sq. ft. of steam heating surface for each square foot of duct area, and not less than 1 sq. ft. of free area through both heating coil and duct for each 350 sq. ft. of floor area. Such an exhaust duct shall discharge above the roof and extend in any case to a height of not less than 15 ft. above the heating coils.

(h) Where mechanical systems of introducing outside air are used, and where air is recirculated the air shall be delivered horizontally and in sufficient volume and with sufficient velocity to secure distribution to all parts of the building. The height of the air inlet opening shall be such that the air will be discharged above the top of the vehicles.

(i) All duct openings, either supply or exhaust, shall be covered with ¼-inch mesh screen.

(j) The passing of air ducts through fire walls shall be avoided wherever possible. Ducts shall be installed in accordance with the regulations for the installation of blower and exhaust systems.

**Section 17. Repair Shops.**

(a) Repair shops shall be ventilated as required for garage storage sections, except that mechanical means shall be provided for both the inlet and exhaust of 1 cu. ft. of air per minute per square foot of floor area.

(b) In connection with engine testing it is recommended that the engine discharge direct to outdoors through a straight duct or pipe of incombustible material, and of suitable size, installed as an extension of the exhaust pipe or muffler, in which case the mechanical system for inlet or mechanical system for exhaust may be omitted.

**Section 18. Fuel Burning Appliances.**

(a) Steam generators for tire vulcanizing, for oil and grease removal and for purposes other than space heating water heaters, and other fuel burning appliances such as forges shall not be installed within bus operating section or within carpenter or paint shop.

**Section 19. Inspection and Repair Pits and Trestles.**

(a) Elevated trestles or hoists are preferable for this service. If pits are used, they shall be continuously ventilated by a system independent of the main garage ventilating system. Such pits shall be cleaned at least daily and no accumulation of oil and grease permitted. Permanent illumination shall be provided.


## Semi-Annual Meeting Papers

**Featured in June and July**

**JUNE**

Analysis of The Over-all Efficiency of a Residence Heated by Warm Air, by Prof. A. P. Kratz and J. F. Quereau.

Pipe Sizes for Hot Water Heating Systems, by Prof. F. E. Giesecke and E. G. Smith.

Instruments for the Measurement of Air Velocity, by Prof. J. H. Parkin.

**JULY**

Time Lag as a Factor in Heating Engineering Practice, by James Govan.

Five Suggested Methods of Appraising Insulations, by Paul D. Close.

Determining Dust Quantities in Air, by Prof. F. B. Rowley.

# PRESIDENT'S PAGE

PRESIDENT THORNTON LEWIS
*Philadelphia, Pa.*

THE JOURNAL of our Society has just completed 14 years of its existence as a separate publication. It is now starting on a new era and will for the next few years be incorporated as a separate section in *Heating, Piping and Air Conditioning.*

Speaking for the Society, I desire to welcome the new publication into the field in which the members of our Society are so much interested. I also wish for them a successful and profitable existence and express the hope that our JOURNAL appearing in their magazine will serve a greater usefulness to all engineers and those interested in the art of heating and ventilating.

In a way the new era is an experiment, though there is every reason to believe that the influence and usefulness of the Society and its publications will increase during the coming years.

The Code of Minimum Requirements is now being printed and will shortly be issued. Here is the culmination of many years of effort and work and is an accomplishment of which the Society can well be proud. Let us use this Code. Let us find its weaknesses, if any, and offer constructive suggestions for its improvement as time goes on.

Next January the City of Philadelphia will entertain us during the time of our Annual Meeting. While our meeting is in progress the International Heating and Ventilating Exposition will be held, and this will offer many things of interest to those who come to our meetings. Those who come to the Exposition will be welcome in our meetings and we hope will receive some benefit. At least they will be given many things to think about that are concerned with heating, ventilating, air conditioning, etc.

In the immediate future we have to look forward to our Semi-Annual Meeting to be held the last week in June at Bigwin Inn. Here is a valuable opportunity, especially for the younger men in the Society. It is possible to visit a neighboring country, have a splendid outing and at the same time attend the sessions of our National Society.

The hotel rates are very low. The cost of transportation, on account of excursion fares, is moderate and it is the hope of the Officers and Council of the Society that we may have not only the largest summer meeting which has ever been held, but that we will have several times the number of young men attend who have ever before attended a meeting of the Society.

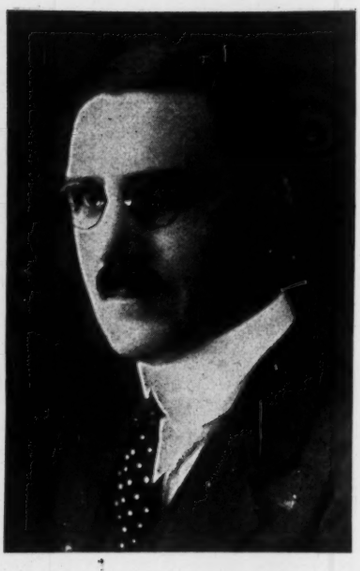
Let us utilize the opportunities that are thus presented to us, not only to make this a larger and better organization, but to also grow individually as men and as engineers.

Sincerely and cordially yours,

Thornton Lewis

April 15, 1929. President.

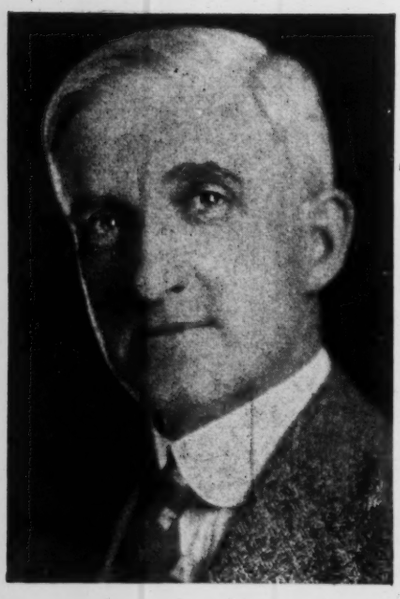
E. B. Sheffield, President Ontario Chapter



M. Barry Watson, Chairman Committee on Arrangements

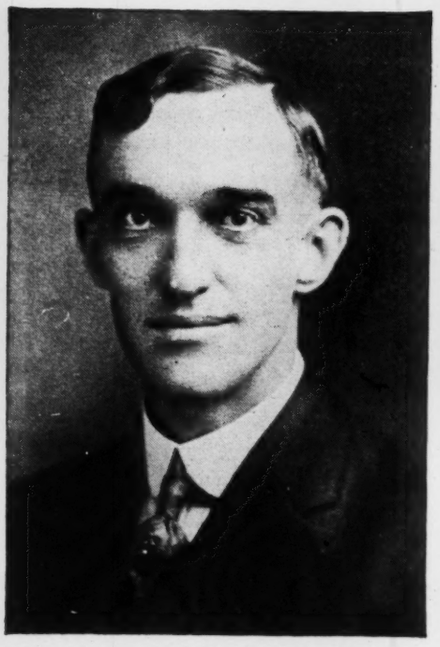
Melvern F. Thomas, Chairman Reception Committee

# Members of Ontario Chapter Who Will Be Hosts of A. S. H. V. E. Bigwin Inn, June 26-28



Arthur S. Leitch, Chairman Entertainment Committee

Arthur J. Dickey, Chairman Finance Committee



Edward M. Dolan, Secretary Convention Committee; Chairman Publicity Committee

# Ontario Members Planning *for* Meeting at Bigwin

## Splendid Technical and Entertainment Program for A. S. H. V. E. Members Coming to Canada for Semi-Annual Meeting June 26-28

FOR many members of the Society, the Semi-Annual Meeting at Bigwin Inn, June 26 to 28, will be their first contact with Canada, and for many others it will be the first time that they have penetrated the interior of Ontario.

There is a big thrill coming to them, as all who have visited the Lake-of-Bays district will testify, and our hosts, the members of the Ontario Chapter, will find it equally pleasant to know that the visitors will be greatly impressed with what they see at this famous resort in the heart of the Canadian woods.

The Committee on Arrangements, under the leadership of M. Barry Watson, is doing everything possible to make this meeting in the Highlands-of-Ontario a memorable one and each of his committee men is giving his time freely to assure the success of the meeting and bring to the attention of the American visitors why it is worthwhile to Come-to-Canada during the last week in June. For the members who have not had the privilege of meeting our hosts, an opportunity is presented in advance of the meeting, and the six photographs presented show a business-like group of Committee Chairmen who are assisting Mr. Watson.

M. B. Watson, Chairman of the Committee on Arrangements, is a consulting engineer, associated with H. H. Angus, the Ontario Chapter's representative on the Council of the Society. Mr. Watson attended the Chicago Meeting and extended an invitation from the Ontario Chapter to all present to attend the Summer Meeting at Bigwin Inn. In addition to this, he had some motion pictures of scenes around Bigwin, which were commented on with enthusiasm, and it is believed that there will be a real big invasion of Ontario by the American Society members in June.

E. B. Sheffield, President of the Ontario Chapter, is compiling all possible information on matters of transportation and he advises that it is possible to reach Bigwin Inn by motor, rail or plane. It is proposed to run a special train from Toronto to the Lake-of-Bays on Tuesday, June 25, arriving in time for dinner in the evening, and it is suggested that each Chapter endeavor to arrange for a special car running via Toronto which can be attached to the *Bigwin Inn Special.*

For those who are motoring, detailed road directions will be supplied by the local committee, as well as all instructions regarding customs, inspection and other necessary data for those traveling from the United States to Canada. Motorists reaching Toronto will be asked to stop at the Chapter's registration and information booth, and it is hoped that the number will be sufficient so that special convoys can be organized and sent to Lake-of-Bays, under the direction of special traffic officers.

The reception of all guests is in the hands of Melvern F. Thomas, who is well known to many Society members, and his committee is arranging to meet everyone on arrival, whether by boat, train, automobile or aeroplane, in order to give proper greeting to the visiting members.

Another very important event for the Summer Meeting is in the hands of A. S. Leitch, Chairman of the Entertainment Committee. Plans are maturing which indicate that those who Come-to-Canada will find a great deal to be seen in so far as natural beauties are concerned, as well as to find enjoyment in many events such as golfing, swimming, fishing, dancing and other forms of exercise and recreation.

One of the important problems in handling the meeting is that of financing, and these duties have been entrusted to Arthur J. Dickey.

In matters of publicity, Edward M. Dolan, Editor of *Sanitary Age,* has had associated with him Wilmott Blackhall and J. S.

BIGWIN ISLAND GOLF COURSE

Patterson, in the production of special literature which will soon come to the Society members.

The entire Ontario Chapter membership is assisting these Committee Chairmen in the work of making this first Summer Meeting of the Society in Canada a memorable one.

At the hotel, arrangements have been made for service on the American plan at the nominal fee of $7.50 per person per day, which includes room and meals. Those who have seen the sample menus, and others who have made it a habit to spend their vacation at Bigwin Inn, find that the food and service are excellent. The hotel rates include boat transportation for those arriving by rali or motor, and permit those who play golf to use the course without extra charge except for A. S. H. V. E. tournaments. Individuals will pay their own caddy fees, as well as garage rental and boat hire.

Plans for the meeting include technical sessions daily from 9:30 a. m. to 1:00 p. m., with the remainder of the time available for members to do as they wish. All business sessions will be held in the pavilion, which is connected with the East and West Lodges by covered passage ways.

Bigwin Inn is reached by Grand Trunk and Canadian National Railways via Toronto and Huntsville from which there is a connecting boat service to Bigwin Inn. Round trip tickets should be purchased, as special excursion rates will be in effect in June.

Railroad and Pullman rates are about as given above.

It is expected that two golf tournaments will be held, a lawn bowling contest will engage some of the members' time, a boat trip will be enjoyed, a tea and bridge party will be provided for the ladies, as well as dancing every evening.

For the fishermen, Lake-of-Bays provides plenty of opportunity for trolling for lake trout and salmon trout. Bass fishing is also good and fishing equipment and guides are available.

ROUND TRIP FARES FROM CHAPTER CITIES TO BIGWIN, ONT.

| From | Fare | One-Way Pullman Fares To Toronto | | |
|---|---|---|---|---|
| | | Lower | Upper | D. Room |
| New York | $39.95 | $ 4.50 | $ 3.60 | $16.50 |
| Newark | 39.95 | 4.50 | 3.60 | 16.50 |
| Philadelphia | 42.77 | 4.50 | 3.60 | 16.50 |
| Boston | 47.22 | 5.63 | 4.50 | 21.00 |
| Cleveland | 27.15 | 3.75 | 3.00 | 13.50 |
| Buffalo | 16.65 | Seat fare $1.50 | | |
| Chicago | 38.05 | 5.63 | 4.50 | 21.00 |
| Detroit | 22.35 | 3.00 | 2.40 | 10.50 |
| Pittsburgh | 31.37 | 4.50 | 3.60 | 16.50 |
| Milwaukee | 42.95 | 6.38 | 5.10 | 21.00 |
| Minneapolis | 61.55 | 9.38 | 7.50 | 32.00 |
| St. Louis | 50.80 | 7.13 | 5.80 | 27.00 |
| Kansas City | 65.30 | 10.13 | 8.10 | 36.00 |
| Seattle | 130.35 | 29.26 | 23.41 | ..... |
| Toronto | 12.30 | Parlor car seat Toronto to Huntsville $0.80 | | |

The Ontario Chapter Committee has written to all Chapters of the Society and President Lewis, in recent correspondence, called attention to the opportunity of members to visit Canada, enjoy a special vacation and a Society meeting, June 26 to 28.

OXTONGUE RIVER AND FALLS, LAKE-OF-BAYS, ONT., ONE OF THE BEAUTY SPOTS WHERE FISHING IS GOOD

## SEMI-ANNUAL MEETING PROGRAM

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

June 26 to 28, 1929

BIGWIN INN, LAKE-OF-BAYS, ONTARIO, CANADA

*Wednesday, June 26*

8:30 a. m.—Registration.

9:30 a. m.—Greeting by Ontario Chapter President.

Response by Pres. Thornton Lewis.

Instruments for the Measurement of Air Velocity, by Prof. J. H. Parkin.

Analysis of The Over-all Efficiency of a Residence Heated by Warm Air, by Prof. A. P. Kratz and J. F. Quereau.

Air Conditioning System of a Detroit Office Building, by H. L. Walton and L. L. Smith.

Report of Committee on Code for Testing and Rating Unit Heaters, D. E. French, Chairman.

*Thursday, June 27*

9:30 a. m.—Report of Committee on Interpretation of Code for Rating Low Pressure Heating Boilers, L. A. Harding, Chairman.

Determining Dust Quantities in Air, by Prof. F. B. Rowley.

Capacity of Radiator Supply Branches for One and Two-Pipe Systems, by F. C. Houghten, M. E. O'Connell and Carl Gutbertlet.

Pipe Sizes for Hot Water Heating Systems, by Prof. F. E. Giesecke and E. G. Smith.

Report of Guide Publication Committee, S. R. Lewis, Chairman.

*Friday, June 28*

9:30 a. m.—Report of Committee on Code for Heating and Ventilating Garages, E. K. Campbell, Chairman.

Time Lag as a Factor in Heating Engineering Practice, by James Govan.

Over-all Heat Transmission Coefficients Obtained by Tests and Calculation by F. B. Rowley, A. B. Algren and J. L. Blackshaw.

Five Suggested Methods of Appraising Insulations, by Paul D. Close.

Report of Advisory Committee on Heating and Ventilating Exposition, H. P. Gant, Chairman.

# 1929 Research Program of A. S. H. V. E.

L. A. HARDING, *Chairman*
COMMITTEE ON RESEARCH

**Committee on Research Sponsoring 15 Problems with Investigations being conducted at Society's Laboratory and at Several Universities**

F. C. HOUGHTEN, *Director*
A. S. H. V. E. RESEARCH LABORATORY

1. STANDARDS OF VENTILATION—Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, U. S. Bureau of Mines, Pittsburgh, Pa.

   As a continuation of the study of the relation of man to his atmospheric environment or determination of standards of ventilation, Laboratory is now:

   a. Determining the heat and moisture given off from the human body for a person working as in the industries.

   b. Measuring the heat and moisture loss from the body of children of school age and the application of the Effective Temperature Chart to school children.

   This study is of value in advancing the knowledge of the application of air conditioning to school ventilation.

2. CAPACITY OF PIPE FOR STEAM HEATING SYSTEMS—Carnegie Institute of Technology in cooperation with the A. S. H. V. E. Research Laboratory, Pittsburgh, Pa.

   In connection with the study of capacity of pipe in various parts of a steam heating system, the Laboratory is now determining the capacity of return mains and risers both for gravity and vacuum pump jobs. This is a major problem and is just now requiring a great deal of work. For the purpose of this study there has been built in the Heating and Ventilating Laboratory of the Carnegie Institute of Technology, a system which will condense steam at the rate of about 2,000 lb. per hour, or 8,000 sq. ft. equivalent cast iron radiation.

3. INFILTRATION—At the A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines, Pittsburgh, Pa.

   Study of air leakage through a stucco and a hollow tile wall. This is a study requiring only occasional observations on the two walls between extended aging periods.

4. VARIATION IN CONDUCTIVITY OF CONCRETE—At the A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines, Pittsburgh, Pa.

   Study of the variation in conductivity of concrete with age of the wall. This is another minor problem requiring only occasional measurements between aging periods.

5. SURFACE TRANSMISSION COEFFICIENTS—At the A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines, Pittsburgh, Pa.

   Study of surface transmission coefficients for various wall surfaces and wind velocities.

6. MEASUREMENT OF AIR FLOW THROUGH REGISTERS AND GRILLES—At the A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines, Pittsburgh, Pa.

   Making a survey of available information on measurement of air flow through registers and grilles with a view of carrying on additional research if necessary, in order to develop a standard method of making such measurements.

7. HEAT TRANSMISSION THROUGH BUILDING CONSTRUCTION—At the University of Minnesota,

Minneapolis, Minn., in cooperation with the A. S. H. V. E. Research Laboratory.

a. Determining conductivity of various building materials with the hot plate.
b. Determining transmission coefficients for various built-up wall sections with the hot box.
c. Study of surface coefficient factors in built-up walls.

8. EFFICIENCY OF AIR CLEANING DEVICES—At the University of Minnesota, Minneapolis, Minn., in cooperation with the A. S. H. V. E. Research Laboratory.

Study of the effectiveness of various air cleaning devices in removing dust with a view of standardizing such determinations and finally establishing a method of rating air cleaning devices.

9. INFILTRATION THROUGH WALLS AND BUILDING OPENINGS—At the University of Wisconsin, Madison, Wis., in cooperation with the A. S. H. V. E. Research Laboratory.

Determination of air leakage through various types of building construction. Brick and tile walls are now being studied.

10. HEAT EMISSION OF RADIATORS—At Purdue University, Lafayette, Ind., in cooperation with the A. S. H. V. E. Research Laboratory.

Development of a standard method of testing radiators for heat output.

11. HEAT AND AIR VOLUME OUTPUT OF UNIT HEATERS—At the University of Kentucky, Lexington, Ky., in cooperation with the A. S. H. V. E. Research Laboratory.

Studies in the method of testing industrial unit heaters with a view of developing a code for test.

12. GARAGE VENTILATION—At the Washington University, St. Louis, Mo., in cooperation with the A. S. H. V. E. Research Laboratory.

Study of garage ventilation with a view of determining air velocities and air changes necessary to eliminate pockets containing sufficient concentration of CO or gasoline vapors to be harmful to persons, or to constitute a fire or explosive hazard.

13. TESTING OF OIL BURNERS—At the Yale University, New Haven, Conn., in cooperation with the A. S. H. V. E. Research Laboratory.

Development of standard methods of testing oil burners with a further view of establishing fundamental data on combustion space necessary for various types of burners and oil.

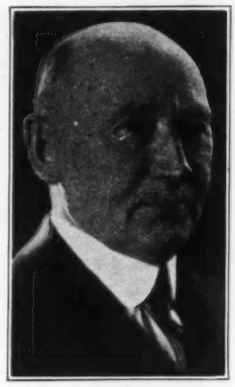
14. VITAL CHARACTERISTICS OF THE ATMOSPHERE—At Harvard University, School of Public Health, Boston, Mass., in cooperation with the A. S. H. V. E. Research Laboratory.

Study of the relation of certain atmospheric conditions to health of persons living indoors.

15. STUDYING PIPE SIZES FOR HOT WATER HEATING SYSTEMS—At Agricultural and Mechanical College of Texas, College Station, Texas, in co-operation with the A. S. H. V. E. Research Laboratory.

Study of the capacity of pipe for various parts of gravity hot water heating systems with special reference to sizing of pipe in such systems in order to give proper distribution.

# Edwin S. Hallett, Chief Engineer of St. Louis Schools, Dies



EDWIN S. HALLETT

After an illness of ten days, Edwin S. Hallett, chief engineer for the Board of Education of St. Louis, and originator of the system of ventilation now in use in the Public Schools in St. Louis, passed away on the morning of the 26th of March, at his home in St. Louis.

Mr. Hallett, a native of Borden, Ind., started his career as a teacher, later becoming superintendent of schools at Corydon, Ind. At the same time he continued his interest in engineering.

After serving as chief engineer for federal buildings in St. Louis and superintending the construction of many government buildings in the Middle West and Southwest sections of the country, he became chief engineer for the Board of Education in St. Louis in 1917.

Mr. Hallett wrote for numerous scientific magazines and was on the board of contributing editors of *Heating, Piping and Air Conditioning*. He was responsible for considerable research work in the study of proper air conditions in public buildings, particularly as applied to school buildings.

Mr. Hallett joined the Society in 1918 and since that time has been one of the most active members, serving on the Council for three years, on numerous technical and special committees and as an officer of the Local Chapter. In addition to this he presented many original papers to the Society, and was always one of the outstanding figures in the discussions on subjects that related to school ventilation.

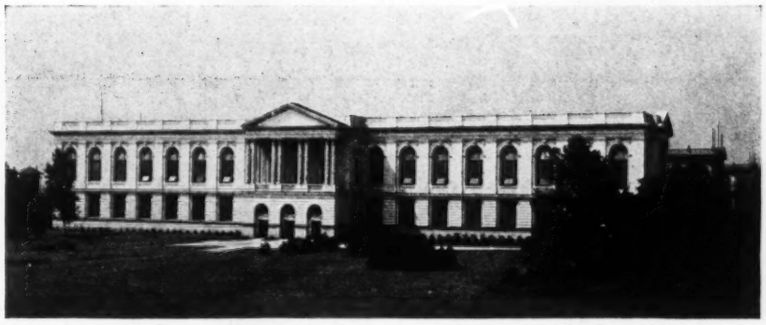
He gained a national reputation among heating and ventilating engineers all over the country by originating a special method of treating the air, used in the St. Louis public schools. About 10 years ago he first used this method of ozonating the air in the schools in order to give the children in the class rooms a better and more healthful atmosphere than the prevailing outdoor smoky atmosphere of the city. Mr. Hallett's plan of air recirculation and ozonizing is credited with saving the Board of Education thousands of dollars for fuel, formerly burned in the old system of heating cold outdoor air brought into the school for ventilation. When Mr. Hallett's idea was tried out it proved so successful that it was immediately adopted, and St. Louis schools won the reputation for fine ventilation.

Mr. Hallett was also a member of the St. Louis Electrical Board of Trade and the *American Society of Mechanical Engineers*. He was active in church and religious work, a member of the Union Avenue Christian Church and teacher of the men's Bible class at the Compton Heights Christian Church.

He is survived by his wife, Mrs. Emma K. Hallett; a son, Samuel G. Hallett; a daughter, Mrs. Philip Gronemeyer; a brother, John M. Hallett; a sister, Miss Linnie Hallett, both of Borden, Ind., and two grandchildren.

Funeral services were held at the Union Avenue Christian Church and burial in the Oak Grove Cemetery.

The officers and Council of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS extend their most heartfelt sympathy to the widow and family of the deceased, who will long be remembered by our members and all those who had the privilege of knowing and associating with him.



Commercial Museum of Philadelphia

# Industry Interested in International Heating and Ventilating Exposition

## First Show Under Society Auspices Opens at Coliseum, Philadelphia, January, 1930

A PROMISING start has been made for an instructive display of heating and ventilating equipment which will fill the Commercial Museum of Philadelphia during the period of the Society's 36th Annual Meeting, January 27 to 31, 1930.

For years heating and ventilating engineers, contractors and others interested have felt the need of an exposition which would contribute to spreading knowledge of the work being done in the heating and ventilating industry, and of the equipment and materials existing and being invented, to help the users of such equipment to a fuller understanding and utilization of more effective equipment.

Manufacturers of heating and ventilating equipment became interested, and the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, realizing that an exposition sponsored by the Society for the industry would need the unqualified support of manufacturers of equipment, appointed a Special Committee of the Council and earnest and thoughtful consideration of the proposal over a long period was given and then favorably reported upon.

With the desire to insure the success of the Exposition, the Society further investigated and concluded that the International Exposition Co., Grand Central Palace, New York, and its management, with an established record in the direction of successful industrial expositions like the Chemical Industries Exposition, National Power Show, National Hotel Exposition, International Flower Show and others, would be an appropriate organization to conduct this Exposition.

It was therefore with genuine confidence that the Society sponsored this enterprise and the Special Committee recommended that the

FIRST INTERNATIONAL HEATING AND VENTILATING EXPOSITION BE HELD IN THE COMMERCIAL MUSEUM, PHILADELPHIA, PA., JANUARY 27 TO 31, 1930

during the period when the Society's 36th Annual Meeting will take place. The city of Philadelphia was selected because it is one of the largest industrial centers of the country with a great diversification of industry. It is also a city of home owners, having over 600,000 individual homes, and therefore offers an excellent opportunity for educational contact with industry and the public.

The Exposition will be brought to the attention of the particular type of persons it is desired to have attend the Exposition. The technical and trade press have shown great interest and will support it. Admission will be by invitation and registration.

President Thornton Lewis has extended the scope of the Exposition Advisory Committee and it is now composed of: H. P. Gant, *Chairman*, Philadelphia, Pa.; A. S. Armagnac, New York, N. Y.; D. S. Boyden, Boston, Mass.; W. H. Carrier, Newark, N. J.; A. C. Edgar, Philadelphia, Pa.; Roswell Farnham, Buffalo, N. Y.; C. V. Haynes, Philadelphia, Pa.; E. B. Langenberg, St. Louis, Mo.; J. I. Lyle, Newark, N. J.; J. F. McIntire, Detroit, Mich.; H. C. Murphy, Louisville, Ky.; F. R. Still, New York City; E. K. Webster, Camden, N. J.; and H. L. Whitelaw, New York, N. Y.

This exposition will be of tremendous benefit to heating and ventilating engineers, architects, contractors, building owners and managers, home owners and builders and the fields allied thereto. It is expected that, like other important industrial expositions, it will bring considerable credit to the industry which it fosters, create a public confidence in the products displayed and be an inspiration to the manufacturers who exhibit, urging them forward with renewed effort and achievement.

The products which will be shown will include every type used in heating and ventilating, encompassing the boilers and furnaces in which combustion is performed, equipment using air, water or other heated fluids for the transfer of heat; systems used to distribute the heat and the radiators for diffusing it in order to create comfort for the human, animal or plant; this range of equipment will include what is used in the individual home as well as what is used in the industrial plant. In this scheme of things there fits in a great complexity of apparatus, equipment, instruments, devices and products. Refractories, insulating materials, blowers, fans, air conditioning and humidifying equipment, pipe and piping systems, pipe fittings, unit heaters and all the control and regulating apparatus and instruments used at any stage in the generation of heat or cooling and ventilating. This enumeration does not contain all the types of equipment which will be included, nor does it include all the supplemental or auxiliary material and apparatus which will be included.

The list of exhibitors who have reserved space to this time include many leading names in the industry. The 65 exhibitors who have already responded and engaged nearly 200 spaces in the Exposition comprise the following list:

Air Control Corp. of N. Y.
American Gas Association
American Gas Products Corp.
American Radiator Co.
Ames Pump Co.
Armstrong Machine Works
Barnes & Jones
Bishop & Babcock Sales Co.
Bryan Steam Corp.
Bryant Heater & Mfg. Co.
Carrier Engineering Corp.
Chicago Pump Co.
Cochrane Corp.
Cooling & Air Conditioning Corp.

Copper Radiator Sales Corp.
Coppus Engineering Corp.
Crane Co.
Direct Control Valve Co.
Domestic Engineering Publications
Domestic Stoker Co.
Dunham, C. A., Co.
Farnsworth Co.
Frank, O. E., Heater & Engr. Co.
General Gas Light Co.
Grinnell Co., Inc.
Hardinge Bros., Inc.
Hart & Hutchinson Co.
Hartzell Propeller Co.
Heating & Ventilating Magazine
Hill, E. Vernon, Co.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Iona Ventilator Co., Inc.
Johnson Service Co.
Kelly Brass Works
Kewanee Boiler Corp.
Kieley & Mueller, Inc.
Korfund Co., Inc.
Leslie Co.
Marsh, James P., & Co.
McDonnell & Miller
McQuay Radiator Corp.
Mears-Kane-Ofeldt, Inc.
Mercoid Corp.
Minneapolis-Honeywell Regulator Co.
Modine Mfg. Co.
Molby Boiler Co.
Multicell Radiator Co.
Nash Engineering Co.
National Regulator Co.
Nesbitt, John J., Inc.
Richmond Radiator Co.
Rome Brass Radiator Corp.
Sarco Co., Inc.
Star Expansion Bolt Co.
Strandwitz & Scott, Inc.
Taco Heaters, Inc.
Time-O-Stat Corp.
United States Radiator Corp.
Vinco Co., Inc.
Warren, Webster & Co.
Westinghouse Elec. Mfg. Co.
Wood Conversion Co.
Wright-Austin Co.
York Heating and Ventilating Corp.

This list indicates the great variety of exhibits which will be displayed, shows the scope of the exposition, its character and the type of appeal it should make. The manager reports that there are many more applications in hand, but that arrangements have not been completed with these firms, therefore their names have not been placed in the list.

This is a most promising start and the entire industry and profession will look forward to an instructive, beneficial and interesting exposition next January at the time of the Society's Meeting.

The Commercial Museum, Philadelphia, is one of the group of buildings located just west of the Pennsylvania Railroad right of way and south of the railroad station in the city. It adjoins the University of Pennsylvania grounds and is easily accessible to visitors and exhibitors.

# Local Chapter Meetings

## Illinois Chapter

*April* 8, 1929. The April meeting of the Illinois Chapter, held at the Hotel Sherman, Chicago, was devoted to the proper method of measuring air quantities delivered by a ventilation system to rooms to be occupied by human beings, the method to include measurements of air quantities at the register faces.

Professor Davies of Armour Institute was the speaker of the evening, and stated that as a result of experiments conducted for the *Ventilating Contractors Association of Chicago*, he considered the anemometer the only generally satisfactory instrument available for measuring air velocities, and that the question narrows down to one of how to use the instrument and how to interpret the readings.

In the experiments conducted at Armour Institute, air was passed through a fan, then through a duct of relatively small cross sectional area, and of sufficient length to permit insertion of Pitot tubes to secure accurate flow measurements, then into a larger duct where the velocity would approximate the velocity through a grille, and the grille was mounted at the end of this duct. Various types of grilles were used to obtain results with different types of free area. The grilles were divided into small rectangular sections and anemometer readings taken in the center of each section, the instrument being held stationary. The experiments indicated this method to be more accurate than moving the instrument slowly over the face of the grille. Readings were taken at a distance of 3 in. from the grille and in contact with it, the latter method proving more accurate, and hence, was used as a basis of all conclusions.

The experiments were illustrated by Professor Davies with slides showing sketches and photographs of the testing equipment, and charts, tables, etc. His conclusions included the recommendation that the anemometer be held in contact with the grille, the area of which should be the mean between the net and gross areas, and the velocity should be the average taken over the entire grille.

In the discussion which followed Professor Davies' talk, Director Houghten of the Research Laboratory of the Society, complimented Professor Davies and the Ventilating Contractors Association on this investigation. He stated that the many inquiries received by the Society and the Research Laboratory fully indicated the importance of this problem, and that a questionnaire recently sent out had indicated a general belief that the present available data is imperfect. Mr. Houghten urged continuation of this study to cover all possible conditions, and believed that the Society would welcome the adoption of the results as a standard. He suggested that experimental work be done with ornamental and unusual shaped grilles.

Others who participated in this discussion were Dr. Hill, Messrs. Hart, Armspach, Getschow and Haines, who all expressed great satisfaction with the results that had been accomplished. It was suggested that the results might be different with highly ornamental grilles where part of the duct running to a register would at times deliver little or no air, and Mr. Armspach suggested that it be specified that the formula quoted is for plain lattice face grilles. Dr. Hill expressed the opinion that it is advisable that the same organization sponsor the completion of this work rather than to have some other body take it over. Mr. Haywood called attention to the previous investigation of this subject by this Society and stressed the importance of continuing the investigation of the problem at the laboratory of the Society until the investigation had been completed.

Mr. Heckel suggested carrying the matter over until the summer meeting of the Society, at which time a recommendation could be made for the adoption of Professor Davies' report with whatever changes and additions were necessary. Among the questions asked were: Was the running start or stop method used in operating the anemometer? Was any attempt made to round off the inside of the grille? When the register face is parallel to the duct in which air is flowing and where air is not directed out of the duct, what results would be obtained? Were readings taken half way between 3 in. from the face of the grilles and in contact with them?

A motion was submitted by A. L. Weixel suggesting adoption of the method outlined by Professor Davies. Mr. Weixel's motion was objected to on the ground that it was too broad and it was pointed out that it is a known fact that an anemometer cannot be placed in contact with ornamental plaster grilles.

At the request of Mr. Sutcliffe, the motion was temporarily withdrawn to permit further discussion of the report. Mr. Sutcliffe warned against hasty action and stated that no consideration had been given to exhaust ducts. He discussed results of similar experiments made by him in the Ilg Company laboratories.

Professor Davies stated that he used the "running start" method of operating the anemometer; that readings 1 in. away differed only slightly from those in contact, which

possibly justifies taking readings 1 in. away in the case of grilles of unusual shape. He stated that further experimental work was necessary to establish answers to the other questions, and that he had not had time to go into these matters.

A resolution presented by Mr. Aeberly, and seconded by Mr. Haines, was withdrawn in favor of a motion submitted by S. R. Lewis, which was unanimously carried:

*Resolved* that the Illinois Chapter of the A. S. of H. & V. E. recommends that for measuring the air supply through a plain lattice grille with an anemometer, the following method be used: Multiply the average velocity of rectangles having between 6 and 10 in. sides over the surface of the grille, holding the anemometer in contact with the grille, by the area obtained by adding the net area of the grille to the gross area of the grille and dividing this sum by two. Further that the Illinois Chapter recommends to the Research Laboratory that co-operative research be entered into as soon as possible with Armour Institute of Technology to continue this study.

Mr. Aeberly then proposed that the chair instruct the Standing Committee to take up this matter with interested groups with a view to having it adopted in the art locally. This motion was carried.

A rising vote of thanks to Professor Davies was sponsored by Messrs. Fleming and Hart. A vote of thanks was also given to the Chicago Ventilating Contractors Association at the suggestion of C. W. Johnson.

It was voted to combine the Golf Tournament of the Chapter and the annual dinner dance on Friday, May 17, 1929, at the Glen Oak Country Club, which is available for the purpose through the courtesy of Colonel Chenoweth. Mr. Tobin of the Grand Trunk Railroad explained plans for transportation of those who will attend the Semi-Annual Meeting of the Society at Bigwin Inn, Lake of Bays, Ontario, June 26-28, 1929. E. C. Prohaska and H. J. Zack were unanimously elected to membership in the Chapter.

## Pacific Northwest Chapter

*March* 21, 1929. A dinner meeting was held at the New Washington Hotel, Thursday, March 21. The attendance, including guests, equalled the entire membership of the chapter.

After the transaction of routine business, W. G. Beggs, chairman of the committee to consider a heating and ventilating code for the City of Seattle, reported the promised co-operation of the State Health Officer to incorporate the desired code in the state organization.

This method of procedure obviates the necessity of the contemplated legislative action and it appears that full authority already is vested in the State Board.

Copies of the proposed code are to be distributed to the membership so that thorough discussion may be undertaken at the next meeting of the chapter.

The City Inspector of Furnaces requested that a committee be appointed for the purpose of investigating fresh air supply to residences housing more than one family, and such a committee is to be appointed by the chairman.

The secretary, E. O. Eastwood, presented several matters of business arising through correspondence, one of which pertained to representation of the chapter upon the Council of the Society. After much discussion of this subject the Secretary was instructed to furnish the Secretary of the Nominating Committee as well as the Secretary of the Society, A. V. Hutchinson, the view of the Pacific Northwest Chapter upon this matter.

The Nominating Committee for local officers for the ensuing year was then appointed as follows: Messrs. Twist, Cox and Hogaboom.

The program was completed by an address by F. H. Camperson of the DuPont de Nemours Co., upon the Construction of the Great Northern Railway Tunnel through the Cascades, with special reference to ventilation features and the exhibit of a film demonstrating the construction work.

## Philadelphia Chapter

*March* 14, 1929. The regular monthly meeting of the Philadelphia Chapter of the American Society of Heating and Ventilating Engineers, was held at the Engineers Club on March 14, 1929.

The meeting was called to order by President Edgar, after which the minutes of the February meeting were read and approved.

The certificate of Honorary Membership awarded at the Annual Meeting of the Society in Chicago, was presented by Thornton Lewis, president of the Society, to Stewart A. Jellett. Mr. Lewis, in making the presentation, outlined briefly Mr. Jellett's many accomplishments in the field of heating and ventilating, and gave high praise to him, not only for his leadership and service in the organization of the Society and the work he did as the first president, but for his many attainments as a scientist and scholar. The certificate carries the following citation:

> The American Society of Heating and Ventilating Engineers hereby confers Honorary Membership upon Stewart A. Jellett in recognition of the debt which the arts and science of heating and ventilating engineering owes to him.
>
> As a Charter member and the Society's first president, as an engineer of outstanding attainments and because of his many contributions to the upbuilding of the heating and ventilating engineering profession, it is desired to commemorate his accomplishments and his service to the Society.

Mr. Jellett, in accepting Honorary Membership in the Society, first took occasion to express his appreciation and thanks for the unique honor conferred upon him, stressing particularly the fact that only in very rare instances, has a Charter member of any organization ever been elected to Honorary Membership in the same organization. In a delightfully reminiscent mood, Mr. Jellett then recounted some of his very early experiences in the heating and ventilating business, relating a number of instances leading up to the organization of the American Society of Heating and Ventilating Engineers.

The speaker of the evening, Lucien Buck, who was then introduced by President Edgar, gave a very interesting talk, illustrated with slides, covering industrial drying problems. Discussion was led by Thornton Lewis, and Mr. Jellett, who mentioned a number of drying problems which he had personally solved during his long engineering experience, calling particular attention to the fact that each drying problem must be considered separately from any other problem and cautioning the younger and less experienced engineers to avoid the mistake of assuming that because one material may have been dried successfully by a particular method, that it did not necessarily follow that some other material could be dried in the same way.

At the conclusion of the discussion, a rising vote of thanks was extended Mr. Buck, on motion of J. D. Cassell.

The Treasurer's report was then read and approved, after which F. D. Mensing took the floor to urge all members of the Philadelphia Chapter to make an extra special effort to attend the Semi-Annual Meeting at Bigwin Inn, Ontario, Canada, June 26 to 28. A. V. Hutchinson, Secretary of the Society, also supplemented Mr. Mensing's remarks in regard

to the Summer Meeting, giving it as his opinion that this would be the most enjoyable meeting ever held by the Society.

Merrill Blankin, chairman of the Meetings Committee for the next year, outlined a tentative schedule of meetings, and urged all members to express their preference in regard to the kind of talks they prefer.

After all business had been attended to, the meeting adjourned.

## Minnesota Chapter

*March* 11, 1929. The March Dinner Meeting of the Minnesota Chapter was held at the Men's Union Building, University of Minnesota, and the speaker of the evening was Mr. F. C. Houghten, Director of the Research Laboratory, Pittsburgh. Mr. Houghten gave us a very interesting lecture on "The Work of the Research Laboratory and Its Influence on the Present Practice of the Heating and Ventilating Engineer." The lecture was fully illustrated by numerous lantern slides. The discussion during the lecture and at its completion brought out many points of interest. The meeting adjourned at 8:15.

## New York Chapter

*April* 15, 1929. The New York Chapter of the American Society of Heating and Ventilating Engineers were guests of the Carrier Engineering Corp., Newark, N. J., at the April meeting, the attendance, including members and guests, being about 250.

An inspection of the plant of the Carrier Engineering Corp., was made in the afternoon, and an opportunity was afforded of seeing the manufacturing operations of the Weathermaker and the Aerofin Units.

A splendid dinner was served, after which entertainment was furnished by the employes of the Carrier Engineering Corp. In the evening Mr. Lyle, past president of the Society, gave a talk on the air conditioning installation in the House of Representatives, Washington, D. C., and illustrated his lecture with slides.

The opinion was unanimous that the program was a most entertaining one, and the Chapter is very much indebted to the Carrier Engineering Corp. for their splendid hospitality.

This was the last regular business meeting of the Chapter, and various reports were submitted including the Treasurer's report by F. E. W. Beebe, Secretary's report by E. B. Johnson, the Auditing Committee's report by the Chairman, L. K. Berman, and the Teller's report by H. G. Issertell.

The officers for the year 1929-1930 who were unanimously elected, include E. J. Ritchie, *President;* A. J. Offner, *Vice-President;* F. E. W. Beebe, *Treasurer;* E. B. Johnson, *Secretary,* and a *Board of Governors* consisting of H. B. Hedges, Russell Donnelly and Dr. C. W. Brabbée.

Dr. A. A. Adler reported his trip to Albany for which he had been delegated to represent the Society to oppose a Bill introduced in the Legislature to create a commission to pass on all heating plans, provide for an inspection service, and provide an installation code and registration of master steam fitters. Dr. Adler stated that the opposition to the Bill was so strong that it was doubtful if any headway would be made with it.

During the course of the evening Mr. Lyle called attention to another Bill proposed in the State Legislature in New York which would require every theatre outside of the Cities of New York and Buffalo to use outside air for ventilating systems entirely, not permitting the use of any recirculated air. The president of the Chapter was empowered to appoint a committee to investigate and take such action as is deemed advisable.

## St. Louis Chapter

*April* 3, 1929. As a tribute to E. S. Hallett, who died on March 26, 1929, a Memorial was adopted by the Chapter at the April meeting at the Roosevelt Hotel. This Memorial was suitably engrossed and tendered to members of his family.

The speaker of the evening was H. G. Fitzgerald, whose subject was "Fooling the Public." Mr. Fitzgerald called attention to various ways in which the public and heating trade are fooled, quite frequently to their benefit.

After Mr. Fitzgerald's talk, a round table discussion of heating problems was held, particularly with respect to the position of the heating engineer in the community.

The Entertainment Committee reported that arrangements had been completed for the Spring Dinner-Dance at the Westborough Country Club. This dance was held April 9, 1929, and was well attended.

T. J. Hester was appointed chairman of the Committee to encourage interest in the summer meeting, with the object in mind of establishing a record for attendance of St. Louis members.

*March* 6, 1929. The March Meeting was, as usual, held at the Roosevelt Hotel, and after the dinner R. C. Chappel of the St. Louis County Gas Co., gave a talk on gas heating, which was not only interesting, but instructive, and showed a very marked tendency toward the use of gas for residence heating.

Mr. Chappel stated that there are at present about 900 installations of gas fired boilers for residence heating in St. Louis and vicinity.

## Western New York Chapter

*March* 18, 1929. The regular monthly meeting of the Western New York Chapter of the American Society of Heating and Ventilating Engineers was held at the Hotel Buffalo, March 18, with Pres. O. K. Dyer presiding and about 25 members and guests in attendance.

President Dyer gave a short summary of the program for the year and called on Roswell Farnham to outline the program for the Summer meeting at Bigwin Inn in Ontario. The distance from Buffalo being short, a record attendance is expected from the Western New York Chapter at the first Canadian Meeting in June.

Hugo Hutzel, a past-president of the Chapter who has returned to the fold, was then introduced by President Dyer. As speaker of the evening, Mr. Hutzel gave a delightful address on the latest developments in the burning of pulverized fuel. Years of experience have fully equipped Mr. Hutzel to speak with authority on this subject, which proved to be very interesting.

He pointed out that for certain applications, powdered fuel was ideal for efficient and economical combustion. Its use, however, is necessarily limited to large projects, as the cost of the essential equipment is great.

Powdered fuel burns like oil and gas and the resultant ash is so fine that it cannot be discerned rising from the chimney. The combustion chamber must be at least 15 feet in length, because of the exceptionally long flame travel. If the flame impinges on the wall, it forms a slag which is very difficult to remove.

Mr. Hutzel also explained that there is a 20 per cent depreciation on pulverizing machinery and the entire equipment must be replaced every five years. The pulverizing cost itself runs from .75 to $2.00 per ton.

A general discussion followed Mr. Hutzel's talk, after which the meeting adjourned.

# Of Interest to Members

## Report on Constitutional Amendments

Pres. Thornton Lewis appointed the following Board of Tellers to count the ballots of members who voted on the amendments to Article II and III of the Constitution of the Society, submitted at the 35th Annual Meeting in Chicago, January 28 to 31: R. H. Carpenter, *Chairman;* D. H. Faulkner and H. B. Eells, all of New York.

The report of the tellers is as follows:

In accordance with the rules governing voting on Amendments to the Constitution of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, your Board of Tellers reports 683 votes cast as follows:

| | *Yes* | *No* |
|---|---|---|
| Article II, Section 7..... | 646 | 9 |
| Article III, Section 3..... | 643 | 12 |
| Article III, Section 4..... | 640 | 15 |

## The Professor of Weathermaking

Under the title, Ordering Your Own Weather, Alfred M. Caddell, in the April 7 issue of the *Brooklyn Daily Eagle,* devotes a page to a discussion of air conditioning and the work of Willis H. Carrier, of Carrier Engineering Corp., Newark, N. J.

The article states, "After all these years of discussing the weather people have now commenced to do something about it. The climate doctor, that fellow who travels under the professional title of Air Conditioning Engineer, is now with us to demonstrate how he can make our lives more pleasant."

The author gives an interesting history of the development of air conditioning and describes the application to many well known industries. Concluding, he says, "By the proper cleaning, cooling, heating, humidifying and dehumidifying, and not to forget draftless distribution, air conditioning engineers have converted palaces of amusement into palaces of health. And the same branch of science is now at work in modern churches, in hotels and concert halls."

The article contains a brief history of Mr. Carrier's life work which is so well known to his many associates in the Society and in other scientific and professional organizations of which he is a member.

## Heating and Ventilation Conference at University of Kansas

Several of the Society's members attended a three-day conference on heating, ventilation and plumbing, held at the School of Engineering and Architecture of the University of Kansas, Lawrence, Kan., and discussed various engineering problems at the sessions, held under the direction of Dean G. C. Schaad.

The Research Laboratory as a Factor in Present Progress of Heating and Air Conditioning was the topic of F. C. Houghten, director of the Society's Research Laboratory at the U. S. Bureau of Mines, Pittsburgh, Pa. Hot Water Service and Heat Recovery was the topic of Mrs. O. E. Frank, president of O. E. Frank Heater and Engineering Co., Buffalo, N. Y., and House Insulation was discussed by H. K. Ireland, of Armstrong Cork and Insulation Co., Kansas City, Mo. Conditioning Air for Ventilation was the subject presented by E. S. Miller, Carrier Engineering Corp., Kansas City, Mo., and Heating with Steam Below Atmospheric Pressure was the subject of C. A. Thinn, of C. A. Dunham Co., Chicago, Ill. The Cost of Heating with Various Fuels was discussed by L. W. Millis, of Security Stove and Manufacturing Co., Kansas City, Mo., and the Use of Gas for Domestic Heating was the topic of Geo. B. Glaskin, of the Kansas City Gas Company.

During the dinner on Wednesday evening Dr. E. H. Lindley, chancellor of the University of Kansas, made an address.

The entire morning session on April 10 was devoted to the discussion of sanitary topics by Ernest Boyce, Engineer for State Board of Health; Miss Selma Gottlieb, chemist for the State Water and Sewage Laboratory; W. J. Dixon, of Kansas City, and S. Lewis Land, education director of the Plumbing and Heating Industries Bureau, Chicago.

L. T. Tupy, Associate Professor of Economics, University of Kansas, discussed Accounting Methods, and the subject of Foreman Training was given by Merril R. Lott, Kansas City.

The heating and ventilating program at the University has been encouraged and sponsored by the Kansas City Chapter of the Society and a number of the Kansas City members were present, including Messrs. Kitchen, Henrici and Ireland. Other society members who participated in the discussions were P. W. Sodemann, St. Louis, and John F. Hale, Chicago.

## Steinhorst Moves to New Plant

Theo. F. Steinhorst, treasurer of Emil Steinhorst & Sons, Inc., Utica, N. Y., announces the removal of the company's offices and plant to 612 South Street, Utica. The new plant is equipped with modern power driven machinery and the company will be able to produce its complete line of sheet metal products, warm air furnaces and specialties to better advantage.

The company was organized in 1908 by Emil Steinhorst, who opened a small shop at 423 Square Street, and in 1920 Mr. Steinhorst took his eight sons into business with him and incorporated the firm.

## A Little Research in Florida

The chairman of the Committee on Research, L. A. Harding, Buffalo, N. Y., has returned from a two months' stay in Florida ready to tackle all problems that may arise and is prepared to give some of the Society's par and nearly par golfers a real battle on the course at Bigwin Inn next June.

CHAIRMAN HARDING TAKES TWO PUTTS ON THE GREEN

With his Walter Hagen driver and the opportunity he has had to increase the accuracy of his play by taking pot shots at meadow larks, eagles and alligators that encumber the Pasadena Course-on-the-Gulf, there is little reason for him to fear the hazards of narrow fairways, woods, water or wild animals.

A characteristic pose reveals Mr. Harding giving concentrated thought to a putting operation. This was caught by our inquiring photographer, who happened to be in Florida.

Mr. Harding reports that Messrs. Carrier and Haynes were seen taking early morning workouts on the course, but they had departed for northern points before our official photographer arrived. A most pleasant time has been enjoyed by Mr. and Mrs. Harding during their stay on the beautiful Pinellas Peninsula.

## Death of D. M. Nesbit

One of the Society's life members passed away on March 15, 1929, when the death of D. M. Nesbit of Ashwell & Nesbit, Ltd., occurred at Leicester, England.

Mr. Nesbit was one of the Society's oldest members, having signed his application November 12, 1894, and just missed being a Charter Member of the organization.

He was born on May 7, 1855 at Newcaster-on-Tyne, England, and spent his entire life in heating and ventilating work. Mr. Nesbit was prominent in the heating and ventilating profession in England and was a Past President of the *Institution of Heating and Ventilating Engineers of Great Britain.* He was also Past President and Honorary Treasurer of the *National Association of Heating, Ventilating and Domestic Engineering Employers.*

During 1894 Mr. Nesbit visited the United States and became acquainted with many of the men who were instrumental in organizing the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. In December, 1896, Mr. Nesbit planned a trip to this country but the sudden death of his partner prevented him from attending the 1897 annual meeting and presenting a paper which he had in preparation.

Mr. Nesbit was active in many other organizations and in his passing, the heating and ventilating profession loses an active and forceful character.

The Officers and Council of the Society extend to his associates and family an expression of their sincere regret for the loss which they have suffered through the death of their fellow member, who served the profession so long and so unselfishly.

# CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 21 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by June 2, 1929, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary, immediately after election.

| | REFERENCES | |
|---|---|---|
| | Proposers | Seconders |
| AHEARN, WILLIAM JOSEPH, Htg. Engr., The Downey Co., 99 Dedham St., Boston, Mass. | J. F. Tuttle<br>Wm. P. Mower | Coll T. Flint<br>J. W. Brinton |
| ALCOTT, WILLIAM L., The Graff Co., 945 Liberty Ave., Pittsburgh, Pa. | Edwin C. Evans<br>Thomas Chester | Chas. W. Wheeler |
| BLACKBURN, EDWIN CARL, JR., 35 Miller Pl., Hempstead, L. I., N. Y. | David Moffat (*Non-Member*)<br>Harry Brod (*Non-Member*) | W. L. Dudley<br>G. E. Reed (*Non-Member*) |
| BOLTE, EDWARD ENDICOTT, National Radiator Corp., 2445 N. Keeler Ave., Chicago, Ill. | Wm. H. Chenoweth<br>H. G. Thomas | I. N. Soper<br>J. A. Cutler |
| BUTLER, CHARLES WILLIS, Sales Engr., American Blower Corp., Detroit, Mich. | F. J. McMorran<br>J. M. Foster | L. Walter Moon<br>C. A. Pickett |
| CORBIN, WILLIAM EDWARD, Estimator, C. Stanley Morgan, 445 W. Larned St., Detroit, Mich. | C. Stanley Morgan<br>Wm. J. Whelan | L. L. McConachie<br>Matthew H. Goss |
| DAVIS, HERBERT H., Secy.-Treas., Herbert H. Davis Co., Inc., 4146 S. Western Ave., Chicago, Ill. | S. C. Bloom<br>James J. Finan | John Howatt<br>J. P. Fleming |
| DORFAN, MORTON I., Mgr., Dust Collecting Div., Pangborn Corp., Hagerstown, Md. (*Advancement*) | Benj. Adams<br>Walter L. Fleisher | Raymond E. Jones<br>Franklin W. Wandless |
| ELLIOT, EDWIN, Sales Engr., Edwin Elliot & Co., 560 North 16th St., Philadelphia, Pa. | E. Nute Sanbern<br>Frederick D. Mensing | Merrill F. Blankin<br>Alan A. Miller |
| HAKES, LEON MARC, Sales Engr., The R. T. Coe Cos., 907 Gas & Elec. Bldg., Rochester, N. Y. | R. T. Coe<br>Wm. Roebuck, Jr. | C. H. Love<br>H. P. Dempsey |
| HAUPT, HOWARD F., Archts. Repr., American Radiator Co., 288 W. Water St., Milwaukee, Wis. (*Advancement*) | Robert G. Olson<br>Wm. H. Wilson | H. W. Ellis<br>V. A. Berghoefer |
| HELBURN, I. B., Mgr., Air Filter Service Co., 844 Rush St., Chicago, Ill. (*Advancement*) | E. C. Evans<br>H. C. Murphy | F. Paul Anderson<br>Margaret Ingels |
| JARDINE, DOUGLAS CONNELL, Plbg. and Htg. Contr., Jardine & Knight Plbg. & Htg. Co., 312 Custer Ave., Colorado Springs, Colo. (*Advancement*) | O. G. Ward<br>Howard Fielding | |

| | | |
|---|---|---|
| JOHNSON, WALTER F., Mgr., American Radiator Co., 374 Delaware Ave., Buffalo, N. Y. | C. A. Evans<br>W. G. Fraser | T. A. Novotney<br>H. P. Dempsey |
| NAROWETZ, LOUIS LUDWIG, JR., Secy., Narowetz Htg. & Vtg. Co., 1711 Maypole Ave., Chicago, Ill. (*Advancement*) | E. P. Heckel<br>C. W. DeLand | Carl W. Johnson |
| NASON, GEORGE L., Buerkel & Co., Inc., 16-24 Union Park St., Boston, Mass. (*Advancement*) | H. A. Hodgdon<br>W. W. Underhill | E. C. Whitaker |
| PATRICK, HORACE M., Engr., Mensing & Co., 1713 Sansom St., Philadelphia, Pa. | E. Nute Sanbern<br>Frederick D. Mensing | Merrill F. Blankin<br>Alan A. Miller |
| SHANKLIN, ARTHUR P., Sales Engr., Carrier Engrg. Corp., 850 Frelinghuysen Ave., Newark, N. J. | Willis H. Carrier<br>E. T. Murphy | L. C. Davidson<br>W. A. Bornneman |
| SHARP, FLOYD H., Htg. Contr., Chatfield & Sharp, 304 Pine St., Jamestown, N. Y. | W. G. Fraser<br>Marshall S. Jackson | C. H. Love<br>L. A. Harding |
| STERN, JOSEPH M., Iron City Heating Co., 843 Jacksonia St., N. S., Pittsburgh, Pa. | Edwin C. Evans<br>Thomas Chester | John McMurray<br>Peter O'Neill |
| THURNESS, BERNARD EICHOR, York Htg. & Vtg. Corp., 948 Hanna Bldg., Cleveland, O. | Thornton Lewis<br>H. P. Gant | C. D. Graham<br>R. S. Arnold |

# Candidates Elected May, 1929

In the past issues of the Journal of the Society there were posted among the list of Candidates for Membership, 28 candidates for election in the different grades of Membership, whose names have been balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

## MEMBERS

AKERS, GEORGE WASHINGTON, Secy.-Treas., Geo. W. Akers Co., 2847 Grand River Ave., Detroit, Mich.
BIGGS, WILLIAM E., Ch. Engr., W. E. Biggs Engrg. Co., 714-15 Holston Bank Bldg., Knoxville, Tenn.
GRAHAM, CHARLES DANNE, Mgr., Engrg. Dept., York Htg. & Vtg. Corp., 1541 Sansom St., Philadephia, Pa.
HIRSCHMAN, WILLIAM FRED, Pres. and Treas., W. F. Hirschman Co., 220 Delaware Ave., Buffalo, N. Y.
HUBBARD, ALLEN, JR., Engr., French & Hubbard, 210 South St., Boston, Mass.
LEINROTH, JEAN PAUL, Gen. Industrial Fuel Rep., Public Service Electric & Gas Co., 80 Park Pl., Newark, N. J.
RETTEW, HARVEY F., Htg. & Vtg. Engr., Board of Education, 19th & Ludlow Sts., Philadelphia, Pa.
SHERET, ANDREW, Mgr. & Pres., Andrew Sheret, Ltd., 1114 Blanchard, Victoria, B. C.
STANDISH, MYLES, Washburn Garfield Co., 171 Commercial St., Worcester, Mass.
SWANEY, CARROLL ROBERT, Nash Engrg. Co., 25 Huntington Ave., Boston, Mass.
VERMERE, EARL J., Ch. Engr., Erie Heating Systems, Erie, Pa.
ZIBOLD, CARL EDWARD, Pres., Zibold & Donohue Co., Inc., 331 Vanderbilt Ave., Brooklyn, N. Y.

## ASSOCIATES

LATHERS, VICTOR MATTHEW, Salesman, Rome Brass Radiator Corp., 228 N. LaSalle St., Chicago, Ill.
MALVIN, RAY C., Vice-Pres. & Gen. Sales Mgr., McQuay Radiator Corp., 35 E. Wacker Drive, Chicago, Ill.
MAY, MAXWELL FRANK, Asst. Gen. Sales Mgr., McQuay Radiator Corp., 35 E. Wacker Drive, Chicago, Ill.
MEYER, JOHN W., Mgr. of Steam Htg. Sales Div., Philadelphia Electric Co., 1000 Chestnut St., Philadelphia, Pa.
MYERS, JOSEPH EARL, Salesman, Newport Boiler Co., 529 Franklin St., Chicago, Ill.
PETERSON, LESLIE JAMES, Yelton-Weaver Supply Co., Springfield, Ill.
RICE, JOHN ALOYSIUS, Thompson-Starrett Co., Inc., 245 Hunters Point Ave., Long Island City, N. Y.
STAUD, CLEMENT J., Mgr., Htg. Dept., Harris Pump & Supply Co., 320 Second Ave., Pittsburgh, Pa.
WELCH, LOUIS A., Jr., Sole Owner, Welch Bros., 1190 Broadway, Schenectady, N. Y.
WINTERER, ALFONSO V., Secy., Reuben L. Anderson, Inc., 1834 St. Clair St., St. Paul, Minn.
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# Heating · Piping and Air Conditioning

## EDITORIALS

### Inaugurating A Service

This issue makes HEATING, PIPING AND AIR CONDITIONING an actuality to some seven thousand subscribers who have, until its appearance, known it only as a promise by its publishers to cover in a technical and practical way the design, installation and operation of heating, piping and air conditioning systems and equipment. It inaugurates a service each month which the engineering developments and possibilities in its field have made a well defined need. As one issue, it aims to fulfill the promise which has attracted so many readers and, at the same time, to indicate the scope and nature of the service which each succeeding issue can make more complete and more detailed. We hope that to every reader it does this.

### Aims and Policies

It may be well to restate here the aims and policies of this new journal. In the first place, HEATING, PIPING AND AIR CONDITIONING is to be a strictly technical journal. Such a policy commits it to the presentation of the engineering developments and trends in its field as discovered through research and experience. It further commits it to the practical interpretation of such developments and to the presentation of their application to the problems which arise in the work of design, installation and operation. It follows that its service will include examples that illustrate the engineering essentials to an efficient job of heating, piping or air conditioning.

Thus, it combines the basic engineering principles with the practical to make it a factor that can be put to work by the consulting engineer, by the contractor and by the supervising and operating engineer in industrial plants, institutions, schools, office buildings, public utilities and similar structures in which heating, piping or air conditioning is a vital part of the mechanical equipment.

### Heating

Its field in heating is confined to the larger types of construction, as distinct from residential. It is confined to no particular types of heating. Steam, vapor, vacuum, hot water, warm air, electric and district heating are adaptable to the classes of construction to be covered and, therefore, each kind will come in for the editorial attention necessary to keep the reader informed of the developments that contribute to best practice.

### Piping

In piping, an appreciation of the importance of the efficient distribution and utilization of the steam, water, air, oil, gas, refrigerants and the many process liquids in industrial plants is to be backed up by an editorial policy which will concentrate on this phase of plant design and operation. As one of our writers puts it, there is little to be gained in generating the various forms of energy economically in the boiler room and then wasting such savings by inefficient distribution—or, in other words, by using improperly designed, poorly installed and carelessly maintained piping.

There is such waste. Piping has its very direct relation to the coal pile. It should be, therefore, correctly designed and installed. Proper sizes, proper materials, proper supports, with their detailed calculations of friction losses, pressure drops and such factors, are the problem of every industrial plant. The trend toward higher pressures and temperatures is putting entirely new demands upon the distribution system. There is ample reason for giving piping constant attention.

### Air Conditioning

Air conditioning today suggests only cooling and humidifying to most engineers and contractors. Rightly it includes temperature, whether heating or cooling, circulation or ventilation, humidification and dehumidification and cleaning, either by the filtering or washing process. Rightly, too, in a sense, it could mean any one of these as well as all in combination. We feel, and it shall be our policy of editorial presentation, that air conditioning will be the generally accepted term for any or all such processes in the future. Thus, it gives us wide latitude in providing an editorial service, and we anticipate the opportunity to play an important part in developing this division of engineering.

Air conditioning is a science the possibilities of which are only vaguely understood by the majority of those whose responsibility it is to utilize its advantages. There is practically no type of building, no process of manufacturing in which air conditioning can not make living and working more com-

fortable and healthful and production more efficient. Thus, we shall make it a point to spread the "gospel" of air conditioning. What it has done, why it was necessary and how it was accomplished, in the instances in which it is now performing, will give the engineer practical information for application to his particular problem. Then, research and experience should result in vital developments as time goes on. It shall be the obligation of HEATING, PIPING AND AIR CONDITIONING to encourage and follow these developments and to present them to its readers as they become good practice.

## A Unified Field

In this brief explanation of what the publishers of HEATING, PIPING AND AIR CONDITIONING see as an opportunity for a unique editorial service, there may be given an impression that heating, piping and air conditioning constitute three distinct fields. To the contrary. They are closely inter-related. We visualize them as a unified field,—unified by the fact that the engineering problems of each are the study, interest and work of the same man, whether he be the consulting engineer who designs, the contractor who installs or the engineer in the plant, institution or building who operates. They are a field further unified by the fact that each of these groups of men, although in widely differing positions, comes together at the point of necessity for engineering understanding of heating, piping and air conditioning problems.

## Staff of Authority

Thus, this first issue inaugurates a service which will proceed on a carefully reasoned plan of operation. In it are shown the co-operation and interest accorded by some of the leading engineers in the field, whose names appear on our list of consulting and contributing editors. Many of them have prepared articles for this number. Others will appear in subsequent numbers. We feel that the advantages to our readers of having access to the authoritative knowledge of such men on engineering matters of timely importance, can not be overestimated.

## A. S. H. V. E. Section

The section of the American Society of Heating and Ventilating Engineers will appear in each issue. HEATING, PIPING AND AIR CONDITIONING has become the official organ of this society for the publication of its research findings, technical papers, proceedings and news. In this way, the members of the society will receive the same editorial material they have found in the society's Journal in the past and, in addition, the material produced by the staff of HEATING, PIPING AND AIR CONDITIONING. Similarly, those who are not members of the society will, in this way, have the privilege of following its activities and engineering developments and, in addition, the material produced by our staff. Thus, from the viewpoint of the reader who is seeking information, the combined service adds up to a very worth while fund of technical and practical data.

## To Sustain Interest

We now leave it to the reader. We hope that the interest and confidence in our announcements, as manifested by the number of subscriptions entered, will be stimulated by the appearance of this first issue. It shall be our aim to make succeeding issues sustain this interest and confidence by the quality and value of their contents.

# "Architermal Plans"

To the Editor—

James W. Irving, Mechanical engineer of Jackson, Miss., sends us a proposal which as far as we know is original.

He proposes that plans of buildings showing the heating and ventilating system should be called *The Architermal Plans.*

Remembering that years ago when the moving pictures first came in we had an orgy of new combination-names, before endorsing this new one, I looked up the roots.

No need to fear on that score; they are genuine and pedigreed Greek, and so are according to purists, not abhorrent in combination.

Architect comes from the word meaning master builder, and thermal from the word meaning heat.

The old languages always have appealed to me because of the many instances in which they can say in one word or two what our present language requires whole sentences to express.

A classic example is the Latin phrase—sine qua non, which very nearly has become an English noun, and which might be written "sinequanon." One might apply it to his sweetie after perhaps having exhausted every other endearing word-painting, and if she doesn't bean him before she realizes what he means when he calls her his sinequanon, she eventually understands that in that little wonderful word he has said that she is "that without which is nothing." She is his sun and moon and stars, his universe, his flowers and music and his inspiration. . . . his sinequanon.

So thanks to Mr. Irving perhaps we shall have a new elimination of waste, and maybe our engineer President will honor it by his august endorsement because of that saving of ink and labor and sound vibrations.

"Architermal Plans"—It means the heating plans—the architect's plans of the heating system—the plans of the heating and ventilating adapted to the architect's drawings for the construction of the building.

Why, it's almost as satisfactory and beautiful and appealing as is sinequanon!

It goes nicely with Thermodynamics and Isothermal and Cinematograph and other relatives.

We, therefore, offer the new word to the world with our endorsement, and with our hearty thanks to Mr. Irving.

(Signed) Samuel R. Lewis.

# Air Filtration

*By* W. G. Frank

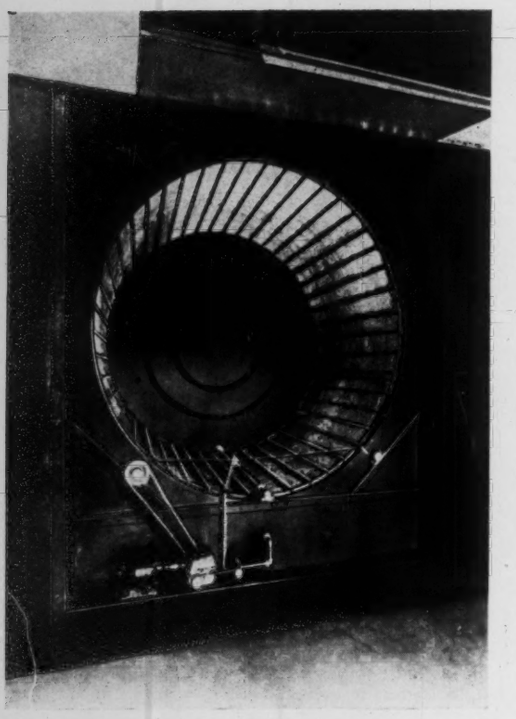


FIG. 1—DRUM TYPE AIR FILTER CLEANED BY FLUSHING THROUGH FILTER MEDIUM. CAPACITY, 50,000 C.F.M.

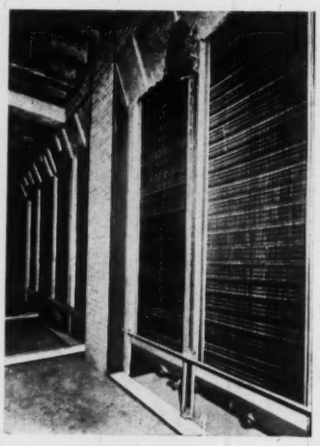


FIG. 2—VISCOUS AUTOMATIC AIR FILTER, ENDLESS SCREEN TYPE. TOTAL CAPACITY, 270,000 C.F.M.

IT WOULD be interesting if we could present graphically the rate of increase in the dustiness of the air during the last fifty years. Such a chart would show a curve, first gently rising, then getting steeper and steeper and, with the approach of the last decade, taking a sharp upward turn. It would show forcefully how far we are removed from the natural condition of the atmosphere, especially in and near the great centers of population and industry. It would help to make us more conscious as to how large a problem we have on our hands in the pollution of our atmosphere.

The products of combustion which escape from the chimneys of private dwellings and factories are the worst offenders. They carry ashes and unburned carbon in minute particles into the air and cover our cities with a veritable blanket of dust. The small particles stay in suspension and are driven to and fro by varying winds. The larger particles settle gradually and mix with the nondescript dust of our streets. This mixture, consisting of every conceivable kind of material, is constantly ground finer and finer by our modern traffic. Stirred up it rises again to increase further the contamination of our atmosphere.

The dust condition in industrial establishments is still more severe. There are few processes of manufacture that do not liberate generous quantities of dust, smoke, gases and odors. Ventilation to protect men, machines and products is usually imperative. Further, clean air of the proper temperature and humidity is an essential factor in many processes. It is, therefore, not surprising that industrial plants were first to respond when air filtration equipment was developed, nor is it surprising that industrial plants invested in filtration equipment as an insurance and protection against the dust-laden air.

### The Function of the Air Filter

Air filtration, as the term has come to be used, is restricted to the cleaning of air of comparatively light dust loads and at temperatures not exceeding 100 degrees F., or, to put it in another way, the cleaning of our ordinary atmospheric air. Air filters extract all those impurities which have the form of globular, granular, and fluffy particles. The larger the particle, the more surely and easily it is eliminated. As the size of the particle decreases it is more difficult to extract it

*Even the aborigines knew how to heat air. We have since learned how to cool it, and control its humidity, but only in recent years have we come to demand that the air we breathe be free from dust, soot and bacteria. We require equally pure air for our modern processes and machines which are no less delicate than our lungs. Thus, filtration of air is of daily growing importance and is developing into an industry with large possibilities.*

from the air stream. When it finally approaches gaseous form, such as in smoke, the air filter reaches its limitation. It makes no claims of eliminating such extremely fine impurities, although a certain amount of them may be taken out.

Air that is heavily laden with impurities also is not within the scope of the so-called air filter. To clean such air, other types of apparatus are used. These operate on different principles, as, for instance, the dust collector, the gas washer and the electric precipitator. However, it is impossible to draw an exact line between dust collection and air filtration as some types of air filters can be made to perform to advantage in dust collecting systems and are sometimes used in such installations.

### Some Early Air Filter Designs

It is interesting to note how the gradual recognition of air filters and their promotion to a modern necessity have produced changes in the style and type of the filters themselves. It is necessary to go back to the Germany of the nineties to find the original air filter, in which Canton flannel was so arranged as to provide a maximum of area. This filter was highly efficient in air cleaning but unwieldy to handle. It never advanced beyond its first form of large pockets over wooden frames. It was easily torn and difficult to replace when clogged with the impurities of the air.

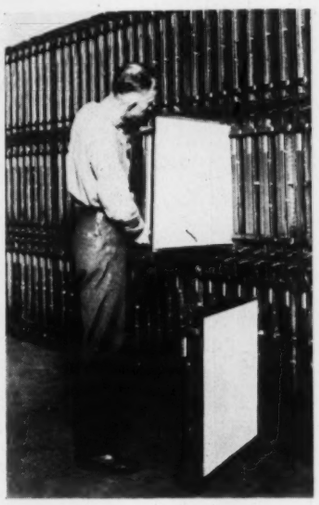


FIG. 3—A NEW DRY-TYPE AIR FILTER WITH CELLULOSE FILTER MEDIUM

FIG. 4—TYPICAL VISCOUS CELL FILTER INSTALLATION

### The Viscous Filter

During the world war, when cotton in central Europe was at a premium and finally disappeared entirely from the market, the metal filter, viscous coated, was born. It had all the advantages of metal construction and lent itself to production by modern methods. But most important, this was a form of filter which made it possible to attack the problem of air cleaning with engineering skill and design.

The viscous filter was conceived to clean the air in a mechanical way, by utilizing the forces of inertia and adhesion. Within the filtering screen, the air is subject to changes in velocity and direction and the dust particles are thrown out of the stream because of their inertia. By coating the filter screen with a viscous fluid, the particles are held through adhesion until washed off through a cleansing process.

Since 1915 numerous types of viscous cell filters were designed and entered the markets of the world. They comprise even today a substantial part of the air filter business. The size of the individual cells has been standardized to 20-in. square. They are shaped so as to fit in frames which can easily be assembled by bolting together. Fig. 4 gives a good idea of the appearance of such an installation. Each cell is provided with two handles to facilitate removal from the frame when the dust accumulation has reached a predetermined maximum. Immediately after its removal, a clean spare cell is put in its place so as to present an unbroken filtering surface to the air. The dirty cell is washed in hot water and washing powder or blown out with live steam. It is then recoated with the viscous fluid and set aside as a spare cell. Thus, the entire installation is kept in working order by routine cleaning of a certain number of cells at suitable intervals.

When the viscous filter entered the United States, it encountered the air washer which had been brought to a high degree of perfection. Its main functions are humidifying and dehumidifying, but it also cleans the air by moistening and separating the dust particles from the air stream. It is well known in the engineering profession how, after a period of readjustment, air cleaning has been largely delegated to the viscous filter, while the washer is used in humidifying, dehumidifying and cooling.

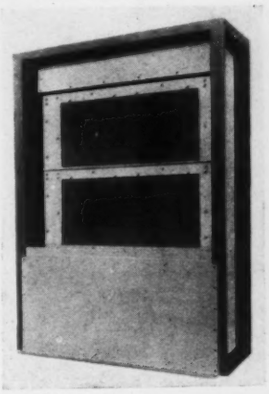


FIG. 5—A NEW FILTER WITH STATIONARY MEDIUM CLEANED BY DOWNWARD FLUSHING

### Automatic Filter

As the applications of viscous cell filters in industrial plants and building ventilation multiplied, it became obvious that the hand service required by such installa-

tions was not in keeping with the development of other modern equipment. The time was ripe for a filter which would operate by the touch of an electric button or even by clockwork without any human attention. An automatic filter of revolutionary design which would do just this was perfected in Germany and introduced in this country. Another filter, operating in a different way but accomplishing the same result, was designed and manufactured in this country. They showed the way to a variety of new designs and the automatic air filter established itself and gradually took the place of the cell filter wherever freedom from manual labor and constant maximum efficiency were demanded.

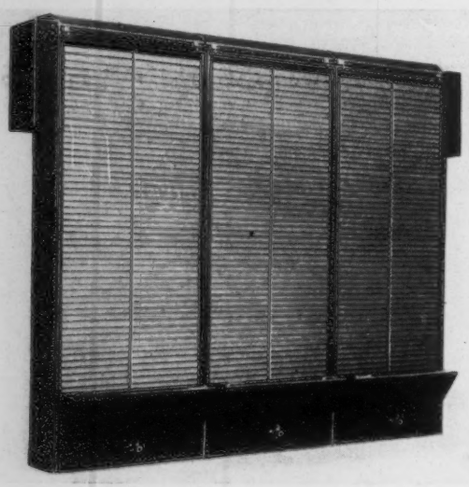


FIG. 6—A RECENTLY DEVELOPED ENDLESS SCREEN TYPE AIR FILTER. CAPACITY, 57,000 C.F.M.

The pictures shown with this article, will furnish an idea of the wide choice of mechanical means which have been employed in the design of automatic viscous filters. They do not attempt to give an exhaustive survey of this type of filter but illustrate some of the makes most frequently found in installations in the United States as well as some recent and very promising developments in this field.

The automatic cleaning and recoating of all these filters is based on the principle that the viscous fluid itself will perform the cleaning function, thereby eliminating a separate washing agent. According to this process of self-cleaning and self-renewing we can now distinguish clearly three principal classes of automatic viscous filters.

### Three Principal Kinds of Filters

In the filters of Fig. 2 and Fig. 6, the medium is arranged in the form of an endless screen suspended vertically from sprockets. Its lower portion is submerged in a reservoir filled with the viscous fluid. By rotating the screen slowly through this bath, the accumulated dust is washed off and drops to the bottom of the reservoir. At the same time the part of the screen which rises out of the bath is coated with a fresh adhesive film and is ready to receive a new load of dust from the air stream.

The designers of the filters shown in Fig. 1 and Fig. 7 accomplish the cleaning process and the renewal of the adhesive film by flushing the viscous fluid through the filter medium in the direction opposite to the air flow. The medium of the filter in Fig. 1 is placed on the outside of a large drum, which is open on one end for the escape of the clean air. A revolving flush pipe is placed within and at the lowest point of the cylinder. The drum turns very slowly, thereby continually bringing new portions of the filtering area under the viscous stream discharged through orifices in the pipe. The filter of Fig. 7 shows the medium arranged in a number of stationary shelves which are served by a common flushing mechanism. This travels back and forth in front of the filter and discharges the viscous fluid through a series of pipes placed closely above the filter medium.

A third group of filters is illustrated in Fig. 5 and Fig. 8. The filter medium is arranged vertically and is stationary. The viscous fluid is pumped into an overhead tank and when released flushes down over and through the medium. It is received in a floor tank where the dirt precipitates, leaving a layer of clean viscous fluid on top.

In the foregoing paragraphs, we have given only the outline of the principles upon which the function of these automatic filters is based. A number of interesting details can be found on each of these filters which make them truly automatic. We refer to the mechanism controlling the operation, to the handling and clarifying of the viscous fluid, and to the extraction of the sediment consisting of the dirt which has been removed from the air.

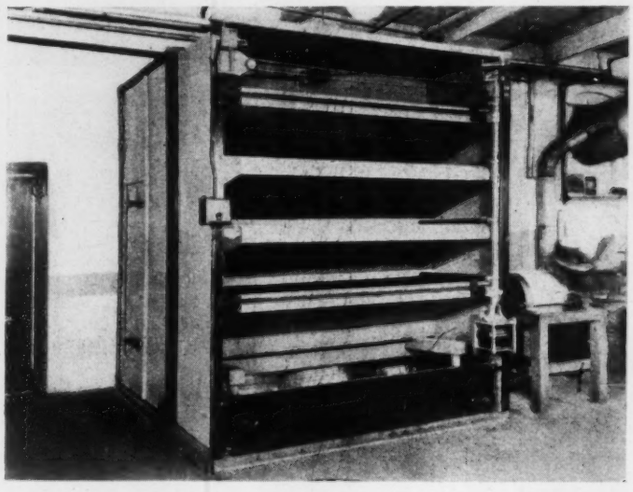


FIG. 7—SHELF TYPE AIR FILTER OPERATED BY FLUSHING THROUGH FILTER MEDIUM

In every automatic filter described, the operation of the cleaning and renewing process is intermittent. The washing periods are timed in such a way that the static pressure drop across the filter remains constant at all times. The variety in the process of self-renewing suggests that the nature of the filter medium in the various

types will be substantially different. In fact, we find this to be the case and are able to group these filters in a different way according to the predominant characteristics of their filtering medium. But, as theories of dust elimination are involved, we will be content merely to point to this difference in the make-up of viscous automatic filters.

About a year ago, a filter of radically different construction and not operating on the viscous principle was brought into the ever-widening market of air filters. This filter is shown in Fig. 3, and is of all metal construction. It employs a cellulose filter mat, inserted between wire frames. In a way, this filter makes us think again of the old cloth filter with its high efficiency obtained by straining the air through innumerable microscopic passages. But the new filter is flexible in application and the medium can be renewed in a moment and without any effort. It features the idea of renewal by discarding an inexpensive material when used up without appreciable labor or expense.

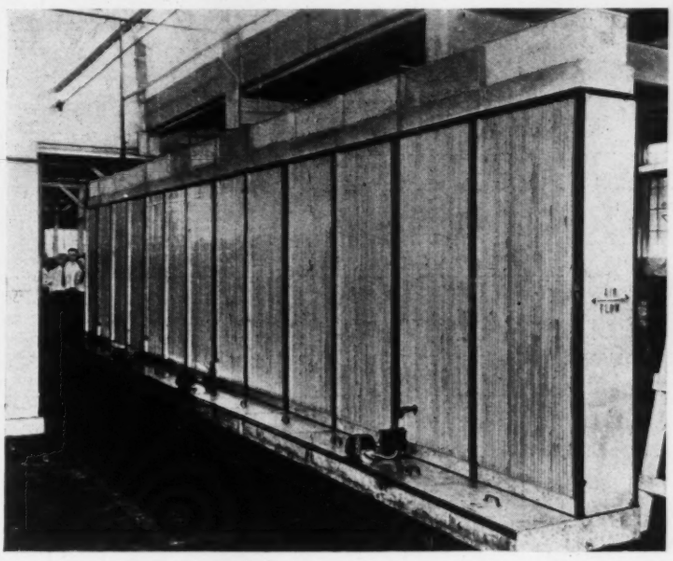


FIG. 8—FILTER WITH STATIONARY MEDIUM CLEANED BY DOWNWARD FLUSHING. TOTAL CAPACITY, 156,000 C.F.M.

### Uses of Air Filters

With the increased popularity of air filters, the proportion of their two principal markets has gradually changed. Designed originally for industrial purposes, air filters found their first large opportunity in the cleaning of cooling air for electric motors and generators. From this start, they were quickly adapted for the protection of compressors, internal combustion engines and for important processes such as food manufacture, drying, finishing and paint spray removal. Complete ventilating systems, distributing air which had been passed through air filters, followed as a logical consequence in many plants where the dust nuisance was a severe handicap to the efficiency of the employes.

In the ventilation of public and office buildings, the benefits of clean air were not so easy to prove as in industrial ventilation. If, however, there were at first any doubts as to the economical returns of the small investment in air filters, they were quickly dispelled as buildings in the United States grew larger and congestion increased. Filters became a recognized and indispensable part of any up-to-date ventilating system. As a result, the total number of air filters in building ventilation exceeds today by far that of all industrial applications combined.

From a scientific standpoint much remains to be learned in this new art. A great deal of research will be necessary before we fully understand the complex actions which take place in air filters. The American Society of Heating and Ventilating Engineers has recognized the great importance of these questions and has sponsored a promising investigation which is being made by the University of Minnesota under the direction of Prof. F. B. Rowley. It is intended to establish a standard of air cleanliness, as well as a standard of performance by which different filters can be compared. A broad study of the whole field of air filtration will be necessary, which will benefit the entire industry.

### The Future of Air Filters

What predictions can we make as to the future of air filtration? It is natural that in a business such as this, where improvements and developments are constantly being made, we feel that the record of past performance entitles us to a great deal of optimism for the future. The filters of five years hence may be quite different from our present models. They will be, we are sure, still simpler and more efficient and as we approach this ideal, the use of filters will become more and more universal. They will find their way into every building of industry and commerce.

To get an adequate conception of the field of air filtration one must consider it as an integral part of ventilation, and, in a larger sense of air conditioning, which is coming to mean the heating or cooling, the circulating, the cleaning and the humidifying or dehumidifying of air. In fact, air conditioning without filtration is almost unthinkable—speaking now of demands in our modern buildings.

Outside of the progress made in air filtration, we find new developments, based upon research by modern methods and experience in the field, in the entire line of air conditioning. We have new and more efficient heating and cooling equipment, fans that do their work with less horsepower and we are gaining an intimate knowledge of the intricacies of air motion and distribution without objectionable draft.

It therefore requires no strain on the imagination to visualize the office building and the home of the future as being supplied with conditioned air throughout.

Consider, then, that a filter must of necessity go with each of these systems, and one may gain some idea of the size and scope of this field we are talking about —air filtration.

**PRACTICAL PIPING PROBLEMS**

***Change Piping to Increase Boiler Output***
***The Blind Gasket***
***Emergency Welding Keeps Job Moving***

*by*
**W. H. WILSON**

## Change Piping To Increase Boiler Output

THE accompanying sketch shows how a change in piping and the use of long radius elbows, instead of an angle valve and an elbow of standard dimensions, were resorted to in order to increase boiler output. At the same time, the experience furnished proof that, in changing direction at 90 degree turns in pipe lines, it is better to use an elbow instead of a tee, angle valve or similar fitting.

A certain industrial plant installed a boiler for the purpose of burning shavings and sawdust from the wood mill and rubbish that accumulated throughout the plant. The boiler was formerly a high pressure boiler, manufacturer's rating 250 H.P., with a 6-in. nozzle for the steam outlet. When it was converted into a burner for shavings, sawdust and rubbish it was arranged to furnish steam at low pressure, and the 6-in. nozzle was connected to a 12-in. steam main which supplied steam for the most part for lumber drying kilns, dry rooms for painted material and cabinet shop glue heaters.

The safety valves on the boiler were set to discharge at 10-lb., to comply with city ordinance according to operating conditions. The normal steam pressure on the 12-in. steam main was 2-lb. This steam main also received exhaust steam from a number of steam hammers used for forging work.

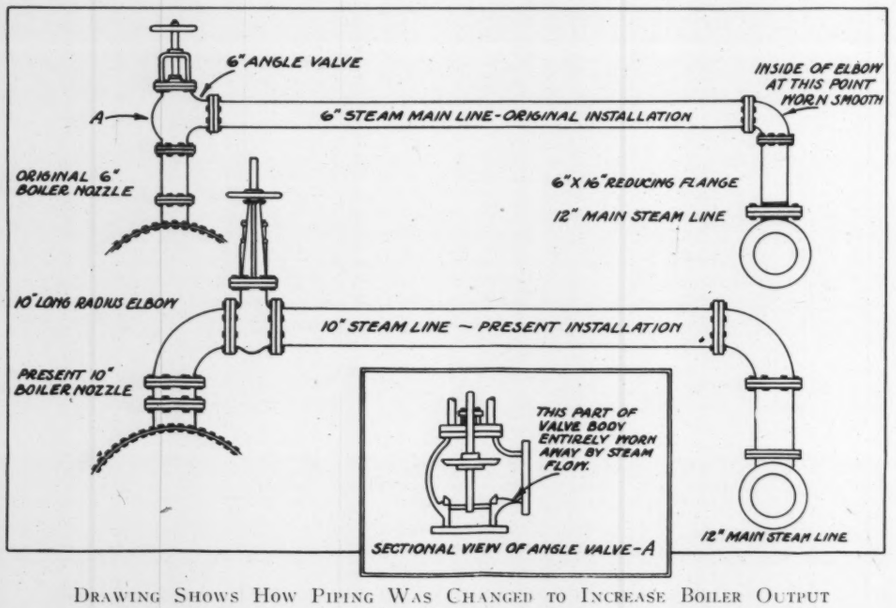
The boiler was hand fired and it was not unusual, when "firing heavy," to have the safety valves discharge to the atmosphere. It was a frequent occurrence for the firemen to slow up on the firing because, as they truthfully said, "What's the use? Steam is only wasted anyway."

Tests were made by applying pressure gauges at different points on the steam outlet and 12-in. main, and it was decided to take off the 6-in. steam nozzle, install a 10-in. nozzle, increase the 6-in. pipe from the boiler to the steam main to 10-in. and use long radius elbows instead of the 6-in. angle valve and 6-in. elbow of standard dimensions. Alterations were made as shown by sketch.

The output of the boiler was increased and the firemen found that there was nothing to prevent them from putting shavings and rubbish in the firebox of the boiler. And the safety valves quit discharging under normal working conditions.

When the 6-in. piping, angle valve and elbow of standard dimensions were removed, after five years of service, it was interesting to observe that the inside of the 6-in. elbow, at the point shown in the sketch, was worn smooth by the flow of the steam and that the angle valve, which was placed in an upright position, was badly worn on the lower part of the outlet.

While the main trouble in this case was that the 6-in. outlet and piping were too small to take the low pressure steam from the boiler, the condition of the interior of the angle valve showed that eddy currents were detrimental to a free and unrestricted flow and suggested the use of an elbow instead of an angle valve. The smooth surface of the 6-in. elbow of standard dimensions on the longer arc of the interior showed that flow was restricted there, too, and


6" ANGLE VALVE
A
6" STEAM MAIN LINE - ORIGINAL INSTALLATION
INSIDE OF ELBOW AT THIS POINT WORN SMOOTH
ORIGINAL 6" BOILER NOZZLE
6" X 16" REDUCING FLANGE
12" MAIN STEAM LINE
10" LONG RADIUS ELBOW
10" STEAM LINE — PRESENT INSTALLATION
PRESENT 10" BOILER NOZZLE
THIS PART OF VALVE BODY ENTIRELY WORN AWAY BY STEAM FLOW.
SECTIONAL VIEW OF ANGLE VALVE-A
12" MAIN STEAM LINE

DRAWING SHOWS HOW PIPING WAS CHANGED TO INCREASE BOILER OUTPUT

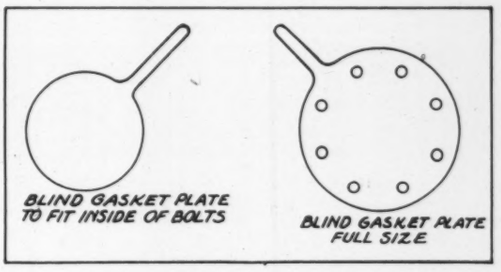
suggested that where there is a flow of any consequence, an elbow of the long radius pattern or a bend is preferable to an elbow of standard dimensions.

## The Blind Gasket

AMONG the problems encountered by pipefitters, both construction workers and maintenance men, in industrial plants when making repairs, alterations, additions or installing extensions to existing pipe lines is that of keeping the plant running with as few interruptions as possible.

The use of a blind gasket can be a help in many cases. The accompanying illustration shows a job in which an elbow was to be removed, a tee substituted and a pipe line extended from the additional opening of the tee. The new line may change direction soon after leaving the starting point. It may lead around machinery, shafting and belting in operation and many other things that would make measurements difficult or consume time in making the final connection at the completion of the work.

A piece of steel, ⅛-inch thick, can be made up in the shape shown. It is common practice to cut it out of a steel plate with the oxy-acetylene cutting torch. The part projecting from the disc, or handle, which must be narrow enough to pass between the flange bolts, helps in putting the plate or disc in position. It is used principally, however, to indicate that a blind gasket is in the pipe line so there will be no chance of misunderstanding in case the pipefitters are put on other work and different men are called on to finish the original job. With the handle projecting, they can tell at a glance just which joint has the blind gasket.

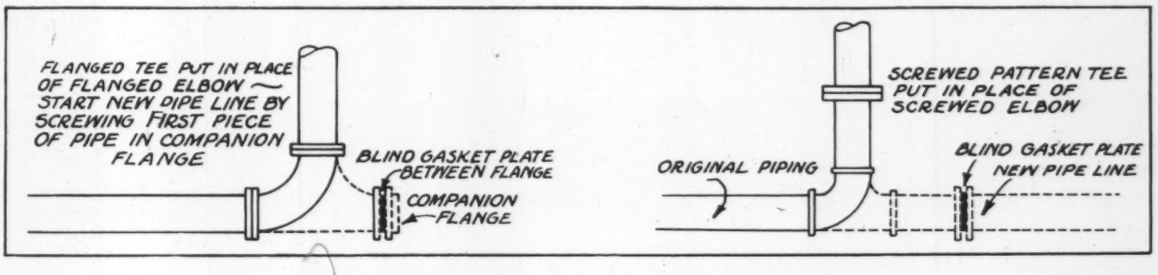



Detail of Blind Gasket and Plate Used in Substituting Tee for Elbow

For low pressures and up to 50-lb. the blind gasket plate may be placed inside of the flange bolts, in which case no bolt holes are required in the gasket. For higher pressures it would be advisable to make a full size gasket with bolt holes, in which case flange bolts would pass through the blind gasket plate. Also, the thickness of the plate should be increased depending on the pressure and the size of the inside diameter of the pipe. It must be understood that in case the pipe measurements are to be very close the thickness of the blind gasket plate and its gaskets must be taken into consideration.

After the blind gasket plate has been fastened in position, pressure may be turned on the original pipe work and it can be put back in operation the same as it was before the work was begun. The starting point of the new pipe work has been securely and accurately established. The new pipe work can now be installed, without any danger from leakage through a valve (which is important in freezing weather) or from having a valve carelessly opened while workmen on the new line are in close quarters where an accident could not be avoided. This feature is important from a safety standpoint.

When the new section of the pipe work has been installed it may be advisable to test it out before putting it in operation. By putting in a gasket on each side of the blind gasket plate, which should be done when originally inserted, pressure may be applied and the new section of piping given a thorough test.


FLANGED TEE PUT IN PLACE OF FLANGED ELBOW — START NEW PIPE LINE BY SCREWING FIRST PIECE OF PIPE IN COMPANION FLANGE
BLIND GASKET PLATE BETWEEN FLANGE
COMPANION FLANGE
SCREWED PATTERN TEE PUT IN PLACE OF SCREWED ELBOW
ORIGINAL PIPING
BLIND GASKET PLATE NEW PIPE LINE

Showing Use of Blind Gasket in Pipe Line Changes

By tapping an opening in the new piping near the blind gasket plate, compressed air, steam or water can be introduced through the opening and the new piping can be thoroughly blown out in order to remove dirt and scale before placing in operation.

When ready to put the new piping in operation, a shut down of only a short duration is required to loosen the flange joint, pull out the blind gasket plate, replace gasket and tighten the joint. Then the complete system of piping is ready for use.

## Emergency Welding Keeps Job Moving

IN AN industrial plant it was necessary to complete without delay some low pressure steam piping. Certain lengths of 4-inch pipe were needed to proceed with the job. Threading machines were not convenient, as they were in a remote part of the plant, so welding was used to fabricate pipe of the proper measurements. Various random lengths of 4-inch pipe, found around the plant, were adapted to this purpose.

First the various lengths required for the installa-